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ABSTRACT

This document is an interim report of a project funded by the Manpower Services Commission in Great Britain. The main aim of the project is to investigate how information technology (IT) may support the British Further Education Unit's proven curriculum development model. The report is structured around the five curriculum development processes in the model: values and needs, course design, implementation, evaluation and review, and support. Each of these elements is discussed in terms of a five-part classification of IT systems: information centers, information networks, computer-assisted learning, information processing, and image processing. The report contains introductory descriptions of various IT systems and explains how IT can apply to each of the five curriculum processes. Long-term and short-term aims are distinguished, and priorities for action are suggested. The report highlights management issues, staff development, and resources and provides an outline of phase 2 of the project. Finally, it offers detailed appendixes on computer-assisted learning, desktop publishing, expert systems, and interactive video, as well as a glossary and list of further reading. (KC)

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FOREWORD

A study of the development of education technology indicates that teachers and trainers are not easily persuaded to depart from their traditional modes of educational design and delivery. Only a few innovations in hardware have survived the stern tests of fashion, convenience, durability, cost, flexibility and simplicity. Courseware is equally if not more vulnerable. The products of educational technology are thus more often than not marginalised, and are not regarded as central to the educational process.

Information Technology (IT) is demonstrating that it can become a major component of educational technology. Some would claim that it has the potential to change the shape of the educational process, with its increasingly fast access to knowledge. Education and training experience confirms that people – tutors and learners – remain the primary participants in education, and until technology challenges that symbiotic relationship, educational technology will remain marginal.

There is, however, a growing realisation that many learners, actual and potential, would prefer a greater degree of autonomy: with respect to location, time, pace, content, learning strategy, and dependence on the tutor. Flexible delivery modes such as open and distance learning verify this. IT, which was not 'invented' necessarily with education in mind, undoubtedly has the potential to increase the autonomy of the learner, and, unlike many other ed-tech devices, it is underpinned by a strong technological base and a market pressure determined to make it 'user friendly'.

Teachers and managers are constantly under pressure, not least from the FEU, to become more systematic in their approach to how they manage, design, deliver and evaluate that part of the education provision for which they are responsible. The FEU, in supporting a more systematic approach, uses a now familiar model of curriculum development derived from both education and training theory. Its basic components – *values and needs analysis, design, implementation, support,* and *evaluation and review* – are related to well by teachers. This model has proved to be useful and robust, able to cope with a range of clientele – from those with special learning needs, through mainstream vocational, to adult learners with immediate updating needs. It has also been able to incorporate extra disciplines such as marketing and, more recently, educational auditing.

An underlying rationale of the MSC-funded FEU project, of which this document is the interim report, therefore is to raise the awareness of the education and training system to the potential of IT; to explore how this new technology relates to and enhances the basic curriculum processes; and to determine whether the FEU model cannot only accommodate IT-based activity but also assist its development. More fundamentally the project hopes to explore how IT can play a more significant and supportive role in education and training, without reducing the essential people partnership mentioned above.

The project's aims are:

- to explore and demonstrate how IT relates to FEU's proven curriculum development model;
- to adapt that model where necessary;
- to test in operation how much the model can encourage IT's use in education and training.

The project is investigating the extent to which IT can influence all aspects of the FEU model, and, in particular, the support systems which lie at its centre.

This document offers a 'state of the art' overview of IT in educational technology, and analyses the extent to which IT systems and processes can be related to the model. The report is structured first round the five curriculum development processes in the model, and secondly round a five-part classification of IT systems:

- *information centres*
- *information networks*
- *computer-assisted learning*
- *information processing*
- *image processing*

The report contains useful introductory descriptions of various IT systems, and how IT can apply to each of the five curriculum processes. We try to distinguish aims achievable in the short term from those needing long-term development, and we offer priorities for action for you to consider. The report highlights management issues, staff development and resources. Finally it offers detailed appendices on computer-assisted learning, expert systems, desktop publishing, and interactive video.

It is hoped that this analysis of the relationship between IT and curriculum development will help to integrate the two, to the benefit of the learners and the providers. In the meantime, in the next phase of this project, FEU will be completing the matrix shown in Figure 6 through field projects and review. It will also tackle fundamental issues of monitoring and evaluating the benefits of IT in supporting the FHE curriculum.

Jack Mansell
Chief Officer
Further Education Unit

INTRODUCTION

This is the interim report of an MSC-funded FEU project 'Information technology systems in education and training'. Our main aim is to investigate how information technology (IT) may support FEU's proven curriculum development model.

In this report we provide an overview of the current potential of some aspects of IT in that context; we suggest too how their use may be profitably extended. We also briefly explore the implications of this extended use of IT in curriculum development. In particular, we set out the issues people involved in the different stages of curriculum development should consider.

The project does not specifically address the teaching of IT-related subjects (not even computer literacy); nor does it look at the use of IT in administration. However, in this report we *do* mention – in the section on implementation – the classroom use of generic IT systems like databases and spreadsheets. This is because they have great potential across the curriculum, so tutors in many subject areas may wish to know how others are using them with students.

The project has the following aims:

- ◊ to demonstrate how IT relates to FEU's proven curriculum development model;
- ◊ to adapt that model as required;
- ◊ to test how far the model encourages the increasing use of IT in practice in education and training.

Its objectives are:

- ◊ to produce an overview of the main IT-related systems in this area;
- ◊ to analyse how compatible IT learning systems and processes are with the FEU curriculum development model;
- ◊ to develop a network of expertise in the various aspects of IT as they support and test the model;
- ◊ to use exemplar projects to show IT as a support system for curriculum development and implementation;
- ◊ to develop, evaluate, and disseminate IT support materials for FE teachers and trainers.

The planned outcomes are:

- ◊ from Phase 1 – a report, which introduces an IT-based learning and support system;
- ◊ from Phase 2 – reports and material showing how IT may apply to developing specific curricula, to allow a start on developing a staff support document;
- ◊ from Phases 3 and 4 – material, exemplars and reports on how IT-based learning and support systems relate to the general processes of education and training in further education.

The proposed schedule is:

Phase 1 ended with the production of this report.

Phase 2 should be completed by the end of 1987. It involves implementing the relationships and processes identified in Phase 1. We apply and develop IT support systems and networks to exemplify the processes in action.

One key aspect of Phase 2 is the identification of staff development needs. A second involves developing and testing appropriate support material for FE tutors.

For further detail of Phase 2 turn to Section 2(3).

Phases 3 and 4 will last around a year as they progressively build on the experiences gained in Phase 2. Phase 3 involves extending the network to test curriculum and staff support material on a wider basis. The main concern of Phase 4 is to evaluate and disseminate the material and processes.

If you would like to join the project's mailing list, please send your request and details to FEU – Bill Congalton (Project Co-ordinator), Mel Pullen (Project Manager) or Margarette Lincoln. We would also like to know if you have experience, ideas, or examples that might contribute to the project.

We use the word tutor throughout this document to mean the tutor, trainer or teacher responsible for the learning situation in question. Similarly, we use learner for the student, trainee or client.

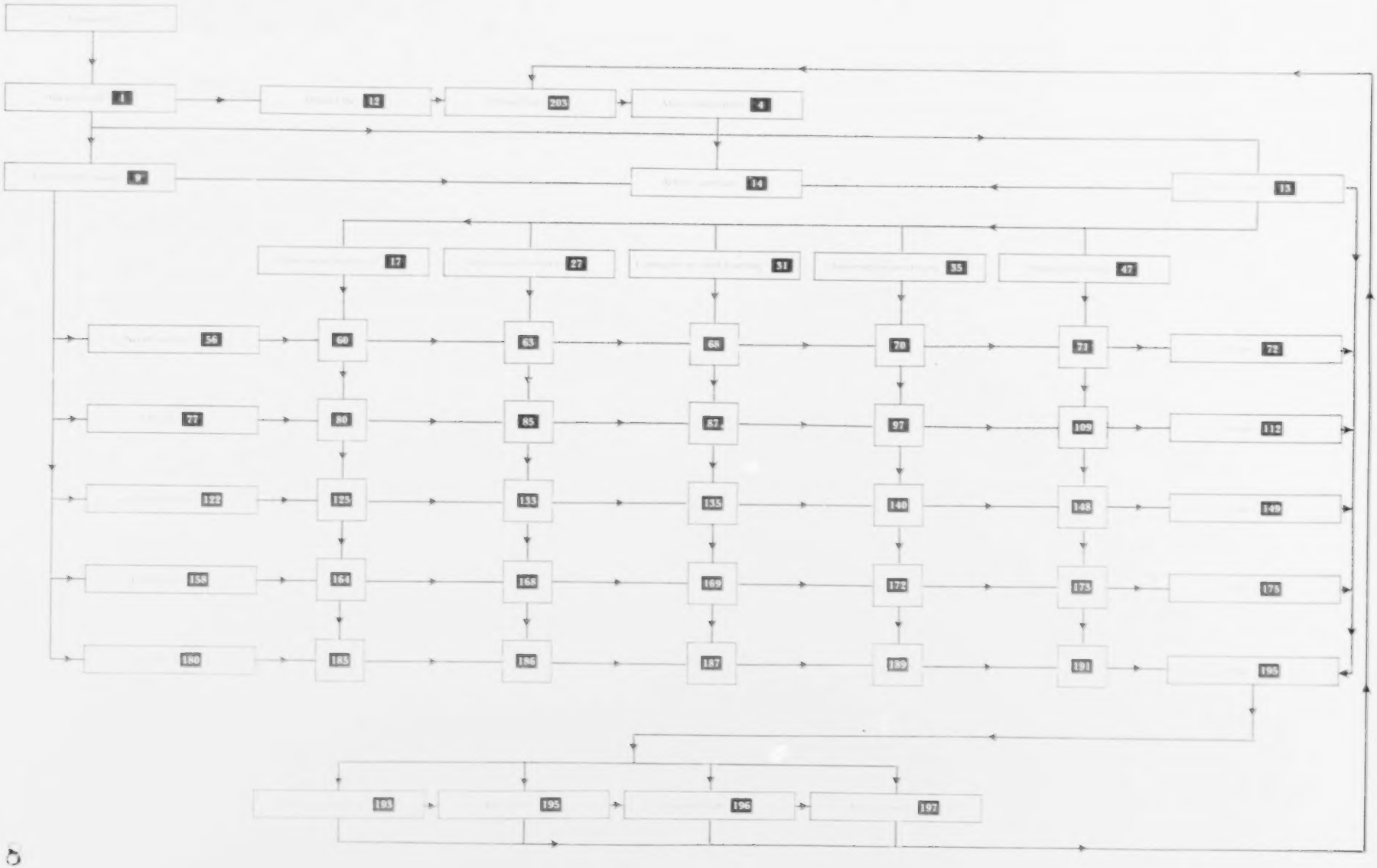


Figure 1: Structure of this report (figures in boxes refer to sections of the report)

USING THIS DOCUMENT

Figure 1 shows the structure of this report and may be used as a quick guide to material of particular interest.

The report is set out in numbered sections and it is to these sections that the references refer.

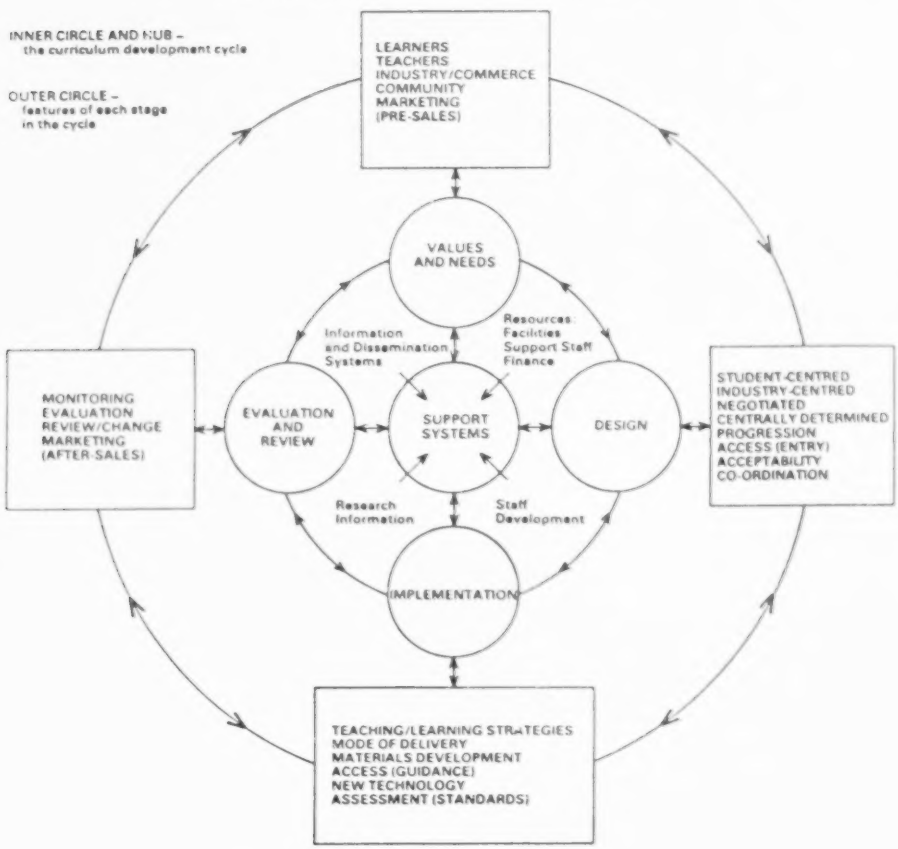
Terms for which such cross-references exist in are shown in **bold type**; after each such term the numbers of sections giving more information and or related ideas are given in square brackets. Codes starting with a letter refer to appendix material.

At the end of the document there are a glossary of abbreviations and acronyms, reading lists and an index.

THE CURRICULUM DEVELOPMENT MODEL

FEU outlined its model of the processes of curriculum development in *Strategy and processes* (February 1986). The model (Figure 2) relates FEU's earlier (1983) curriculum development model to more recent emphases on marketing, progression, delivery, new technology and access.

Figure 2: Processes of curriculum development



This **curriculum development model** [34] has been found robust, useful and relevant. However, it is not seen as prescriptive, for, like all models, it oversimplifies the situation. All the same, we hope it can provide a common reference point to help staff from different sectors of further and higher education (FHE) make their curriculum development experience more explicit, and to share it with others.

Until recently, most tutors had little to do with curriculum development. However, with the introduction of GCSE, BTEC, vocational and adult preparation courses, and short courses for specific markets, college staff are having to exercise curriculum development skills that require a working knowledge of the model.

In the model we distinguish four basic stages in the curriculum development process:

analysis of values and needs

design

implementation

evaluation and review

There is much interaction between these stages, as well as with *central support*. We also recognise that the process may start at any stage. For instance, tutors may have to implement a course they have not designed, or initiatives may begin with evaluation of an existing programme.

We started by finding possible applications links between IT systems and the curriculum development processes in the FEU model.

Obviously, development and work in some areas will be more worthwhile than in others. For instance, **word processors** [68] are widely used in the implementation stage of curriculum development and most people recognise the resulting advantages and implications for those in charge of resources and administration. On the other hand, any work undertaken by the project that involves for instance **expert systems** [71] or the use of **information networks** [72] would be of more value, because so far there has been little of these in this context.

Many systems of **information technology** [73] can be used in curriculum development work; indeed some already show their value in this context. The main systems discussed in this report and considered in the project are:

Information networks [74]
- electronic mail (email)
- teleconferences
- telesoftware
- videotex
- cable

Information centres [75]
- archives
- libraries
- databases

Computer-assisted learning (CAL) [76]
- drill and practice software
- tutorial CAL
- authored packages
- expert systems
- computer-managed learning (CML)

Information processing [77]
- spreadsheets
- graphics software
- computer-aided design (CAD)
- relational databases
- critical path analysis packages
- word processing
- desktop publishing (dtp)
- statistical packages

Image processing [78]
- facsimile (fax)
- video
- interactive video (IV)
- cable systems

This is by no means an exhaustive list of information technology systems. IT in this context includes many others—such as overhead projection, photocopiers, phone answering machines and loggers, the intercom, language laboratories, compact discs, microform, video projectors, speech synthesisers and voice input systems. Most of the systems discussed here are microprocessor-based, particularly computer-based. We omit the others to keep our task manageable and because many are already familiar or are not likely to become common in this context until well into the 1990s.

The matrix in Figure 3 shows the interaction between these curriculum development stages and the various **information technology** IT [15] systems that can provide support. Each cell in the grid contains the number of an action box in this document and of the page where you can find it. These boxes set out the actions — for managers, staff, evaluators, LEA and central personnel, and/or learners — we recommend with regard to the use of given IT systems in given curriculum development contexts.

This document discusses the interactions between the systems and the curriculum processes shown in the matrix.

PROCESSES OF CURRICULUM DEVELOPMENT	**INFORMATION TECHNOLOGY SYSTEMS**				
	INFORMATION NETWORKS	INFORMATION CENTRES	COMPUTER ASSISTED LEARNING	INFORMATION PROCESSING	IMAGE PROCESSING
VALUES AND NEEDS	14	15	16	16	17
DESIGN	18	19	21	22	23
IMPLEMENTATION	26	27	28	29	30
EVALUATION AND REVIEW	32	33	33	34	34
SUPPORT	36	36	36	37	37

THE INFORMATION TECHNOLOGY AREAS

Information technology (IT) is a general term that covers many modern approaches to the storage, handling and transfer of information. The term is a general one because IT involves the convergence of a number of fields – the main ones are computing, telecommunications, office technology, and video, with microelectronics behind them all.

FEU definition:

> *IT is the acquisition, production, transformation, storage and transfer of data (information) by electronic means – in forms such as vocal, pictorial, textual and numeric – so as to facilitate interactions between people and between people and machines. IT also includes the applications and implications (social, economic and cultural) of these processes.*

The bulk of this report deals with the main uses of the IT systems so far considered by the project (and classified in Section 13). Each is briefly described.

Naturally, there is some overlap between the five IT areas we decided to use. Therefore, in cases where we found it hard to assign a system to one particular area, we made pragmatic decisions for the purposes of this project. For instance, we put expert systems into computer-assisted learning.

Information networks

Information networks [**IN**] involve electronic communication. This is the use of modern systems for the transfer over a distance of information (data) between computers, other electronic equipment, and people. The area does not just consist of **computer networking** [**CN**], though this is rapidly growing in importance in further education. Information networks also include new versions of the ways in which people have traditionally passed information – through meetings, discussions, mail, and (more recently) the telex and telephone systems.

A teleconference uses IT for much the same outcomes as those listed above. It allows geographically dispersed people to discuss topic without travel. There are three approaches:

- **computer conference** [**CC**]
- **audio conference** [**AC**]
- **video conference** [**VC**]

By using any of these technologies, a conference can take place without all the participants having to be in the same place.

A **computer conference** [**CC**] involves the use of a computer terminal (or of a microcomputer acting as a terminal) to connect an individual to a larger computer system – a local or (via a modem link to the phone system) wide area network. A modem links computer and phone line; it is needed because the methods of data transfer in the two are not the same.

Once the link exists, a wide range of facilities is available – from the simple collation of a number of messages from different people about a chosen topic, to mediating messages and bringing items to people's attention whenever they connect (log on) to the network. Chat mode is when two people on the network at the same time exchange messages in a continuous conversation. This may be slower than phoning, but each person has more time to think, and each can have a printed record of the discussion.

Electronic mail (email) [**EM**] is for sending messages between people using computer terminals. It is the computer version of telex from the user's point of view – but faster and cheaper. However, email also resembles conventional mail in that messages go through some central handling facility (the store and forward host computer) rather than passing direct from sender to recipient. Telex-like features include 24-hour access, timed delivery, confirmation of receipt and reading, automatic replying, and the ability to send a given message to a number of recipients.

Email is still in its infancy, but is very exciting; a number of organisations offer it, but at present there are no proper inter-service links.

In British education, three services are common:

- ◊ mailboxing on **Prestel** [29];
- ◊ Telecom Gold, perhaps in the form of **TTNS** [25];
- ◊ messaging on JANET (the Joint Academic Network that links universities and some polytechnics).

A more sophisticated form of electronic mail is teletex; this is becoming very popular in some countries but has not yet made much impact in Britain.

Videotex [31] includes two IT systems that may look rather similar on the screen: **teletext** [32] and **viewdata** [34]. In each case, they allow display of information stored in a central (host) computer.

Teletext is a communication method that uses part of a broadcast or **cable** [11] tv channel. (In the latter case it may bear the name Cabletext.) Usually, teletext carries an electronic magazine of around 50,000 words (a few hundred screens full) that modified television sets can access. The service (Ceefax, Oracle and 4-Tel in Britain) provides full screen text of general interest (news, weather, games, travel information and so on), and sub-titles for tv programmes to aid the viewer.

As yet few teletext receivers can print out the information received. However, an adapter lets you load the frames into a computer. With the micro you can then process the information in all the normal ways: editing, printing, saving for later.

Teletext also offers **telesoftware** [24] for people with suitable adapter and computer. This allows the transfer of computer files (mainly programs).

True teletext is available only on broadcast tv, and so cannot permit interaction. With its appearance on **cable** [11] networks (a more interactive medium) the distinction between teletext and viewdata has started to blur.

Viewdata [36] uses more traditional computer communications equipment to provide a rather similar magazine to teletext. Viewdata subscribers make a direct connection between their computer or terminal and a central host, using a **modem** [19] link to the phone network. The viewdata host may store fifty million or more words; these are either in much the same page layout as teletext or as longer files through which the display can scroll. Prestel and TTNS typify the two styles.

The reason that viewdata allows access to far more information than teletext is that the host sends only the information requested – rather than all the time cycling through the whole magazine. While viewdata offers far more information, it has to be paid for:

- ◊ in phone call charges;
- ◊ in most cases, by a viewdata subscription;
- ◊ sometimes by page charges as well.

Many organisations use the same format on a local network to provide private or in-house communications to staff, students and visitors. This approach is **local viewdata** [37] (or microviewdata). Using a similar system you can also offer a Prestel-like service to others phoning in.

Relatively little training is needed in order to use (or even set up) such a system, and it allows access to exactly kinds of information a computer can store. The same is true of the small phone access viewdata hosts some colleges have set up to carry details of courses and so on.

Telesoftware [24] is the transfer of computer files (such as text and programs) over a communications link under the control of the recipient. The main suppliers of telesoftware in Britain are **viewdata** [34] (where one standard is in use) and **teletext** [32] (where each television service has its own standard). In each case, extra hardware is needed – in the first case a **modem** [19] and in the second a **teletext adapter** [22].

File transfer was one of the main reasons for building local communication links (**neiworks** [20]) between computers; as a result, the techniques are well known. The difference between file transfer round a network and downloading telesoftware is that, in the latter case, a computer file is available to anyone with the correct equipment and knowledge to take a copy.

Telesoftware is therefore a cheap way of distributing documents and or programs to a large number of users. The supplier faces no costs of disks or tapes, packaging or postage. There is also less risk of damage to, or interception of, the files in transfer.

An **audio conference** [#18] involves connecting together more than two phone handsets so that up to twenty people can take part in a discussion. You can use ordinary handsets, though loud-speaking instruments are better; the central equipment ensures that only one person speaks at a time.

Because of the lack of eye contact, conference phone calls can be rather wearing compared with a face-to-face meeting; they need clear structure and good chairing. However, they can be highly cost effective.

Video conferencing [#19] is much the same as audio conferencing — but with the addition of still, slow scan, or full definition television pictures for each participant to study. While video conferencing is far more costly than audio conferencing, it allows the participants to see each other as well as to discuss visual images (such as plans or models).

Information centres

Information centres [#] are collections of data organised to make access simple and effective. They are the electronic equivalent of libraries and filing cabinets.

A common name for an information centre is **database** [#]; however, this term does not adequately describe the uses to which it can be put to. **Viewdata** [#] and **teletext** [#] are databases, but the structure of each aids access no more than by being divided into pages or tiles listed on menus (contents screens). The primary purpose of viewdata and teletext is to disseminate information in large chunks.

In contrast, the organisation of the more sophisticated kind of database which we call an information centre lets you, for instance, make searches based on topic, source or date. In some cases you can ask for more complicated searches, ones that require the computer to look for a combination of several different items at the same time.

Electronic archives [#] are common in modern offices; they are analogous to cabinets containing files whose stored information is of value but rarely used.

It has long been possible to save a great deal of space and money by archiving paper material on microform (microfilm and microfiche). It, however, you store the information so a computer can access it, then again there is the potential for an information centre. Typical storage media are magnetic tape, hard disk and, more recently, **optical disc** [#] (including compact disc in the form of the **CD-ROM** [#]). Whatever form the electronic archive takes, access tends to be little slower than with information stored on magnetic disk.

Electronic libraries contain information organised by specialist topic, with each subject covered by one file. The first ones set up were to complement paper libraries in research establishments — but now they can be accessed them from anywhere in the world if you have the right hardware, software and knowledge (and budget).

Most accesses to these systems are by librarians and researchers using computer terminals to carry out literature searches. This is because the files contain mainly reference material. However, there is now a trend towards storing the complete texts of papers and books in electronic form; this will permit more useful searching and open the libraries to a wider public.

Databases [#] are collections of information organised with a clear structure. Thus a given reference in an **electronic library database** [#] would include title, author, publisher, date, abstract and other details.

A number of databases now give information other than bibliographic. Thus, for British education, there are databases of courses available in different subject areas, and of resources that can help with the teaching process.

Computer-assisted learning (CAL)

CAL [#] describes the use of computer systems to assist directly in the learning process. Various terms are current, each with its own acronym; some examples are given in figure 4. We do not attempt to distinguish here between these different approaches (if different they are) – we use CAL to cover *all* uses of computers for learning. An exception is **computer-managed learning** (CML) [#] where the micro's role is significantly different. It should also be noted that computer-based training (CBT) is the term often used for CAL in commerce and industry.

Computers can be used to assist learning in a number of ways. Some simply imitate traditional teaching techniques: drill and practice, tutorial. Others, like simulations and modelling, are better suited to computers as such.

A CAL package in use may or may not require tutor support.

Expert systems [#] and **interactive video** (IV) [#] involve computers and have major implications for learning; we therefore include them here.

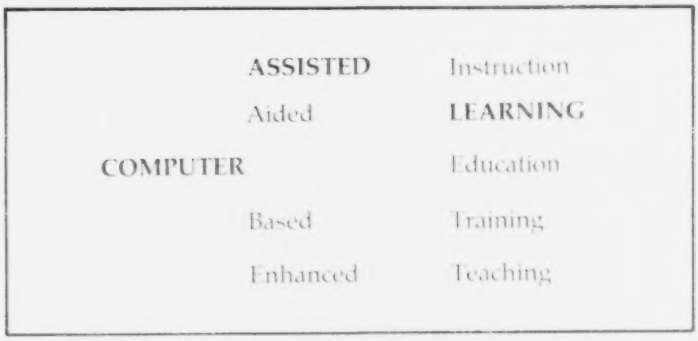


Figure 4 (based on *Computer-based Training: An Introduction for Managers* A National Training Council Research Study, Len Gould, Canberra, 1985).

Expert system [ES] computer programs interpret a set of rules that define a topic or field of knowledge. One definition sees a knowledge-based expert system as simulating human expertise by making valid deductions from given information using the rules of logical inference.

Many expert systems start as empty **shells** [ES Os]. This lets people who are not computer experts develop their own knowledge bases.

An **adviser** [ES C] is an expert system which contains rules and knowledge elicited about a topic. Users who do not have that knowledge can ask questions of the adviser and explore the reasoning behind any particular answer.

Advisers (knowledge-based expert systems) are now of growing importance as a first attempt at enquiry services in areas like medicine, engine maintenance, and oil exploration. Experiments are also taking place into their potential in such areas as social security benefits and airline ticket sales.

People are trying to design expert systems for explicit use as part of CAL delivery packages, to help learners make best use of the information contained. Such an adviser could highlight learning deficiencies and modify its pace and course to cope with individual needs. So far, no real success has followed this quest, so in this report we do not distinguish between expert systems in general and those planned for use in tutorial contexts.

The flexibility and approach to individualisation offered by expert systems make them qualitatively different from traditional computer-assisted learning systems (such as those that involve drill and practice and programmed learning). This is because they do not dictate the learning style or the direction of the learner.

Computer-managed learning (CML) [CL] involves computers in the learning process, but to guide it rather than to provide specific instruction. A CML package may cover:

- the selection of the course(s) a learner might most benefit from;
- planning a programme within the constraints of time, cost and ability;
- scheduling the learner's use of resources;
- assessing the success of a learning process;
- evaluating the administrative aspects of a programme.

CML is not, therefore, specifically concerned with the administration of the learning institution (though it may extend in that direction). Its main concern is with assessing individual learners and their progress toward negotiated aims.

Information processing

Information processing [IP] is a general term that describes the use of computers to process data and information — the mainstream of computer work. Information processing differs from **database management** [DB] in that the software actually interacts with the information content rather than just being a vehicle to carry it.

Spreadsheets [IP] allow you to estimate the effect on your calculations of the entry of a range of data, and to obtain results quickly. You enter the figures and the equations that relate them into the cells of a large grid; you can then change any figures and equations at will. Each time there is a change, the program recalculates the contents of all related cells.

The modern spreadsheet is therefore able to provide rapid solutions to numerical problems you can set out in table form without your needing to know how to write programs. As many subject areas face such problems, it is important to realise that the spreadsheet has great value outside of accounting and maths — many curriculum areas can benefit from its use.

Graphics programs [107] range from modules that help you draw simple pictures to complete systems that will produce full colour motion pictures in two or (via holographic techniques) three dimensions. In the field of personal computing, graphics programs range from simple drawing facilities to software that forms part of **desktop publishing** [42] systems. Such sophisticated graphics software as the last allows you, for instance, to insert a photograph into a text file and edit it, and gives a great deal of assistance to non-artistic users.

Special input devices – such as joystick, mouse, light-pen, or tracker ball – let you make freehand drawings within the graphics software much more simply and cleanly than with a keyboard. Many graphics programs also provide libraries of drawings or sections you can manipulate and add to your own pictures. This may called this clip art in the former case.

A business graphics program will take output from, for instance, a **spreadsheet** [36] in order to produce line graphs, bar charts, or pie diagrams – with captions and titles, labeled axes and marked sections.

Computer-aided design (CAD) is a specialised type of software that combines **graphics software** [47] capabilities with mathematical accuracy. The main use of CAD is for designing components of the kind required by the engineering industries. CAD also helps the development of electronic circuits and their physical layout on circuit boards, and, at the other end of the spectrum, features in the arrangement of fitted kitchens and bathrooms. Indeed, CAD is of growing value throughout industry.

This is also a move to integrate the design of components with their manufacture. This is **cad/cam** [109] – computer-aided design and manufacture; the software programmes the machine tools or robots that make the items once designed.

A **relational database** [97] program allows a computer to store information in a highly flexible structure, such as a tree or a network.

A relational database stores information in a set of tables with each table handling only one type of information. For instance, a file held in the database may include a table with clients' addresses and a second with the courses they have started. It is possible to store almost any kind of information in a database, and the systems permit most traditional information handling tasks with relative ease, as well as offering novel ones.

Relational database programs vary from the complex to the simple. Complex types expect you to have some programming knowledge in order to enter and retrieve information. At the other end of the scale, you can control a simple database by commands expressed in basic English.

Many database programs are available for personal computers. While at the moment few are truly relational, this is changing rapidly as buyers expect more for their money.

Word processing [100] is now a very well known use of computers; it was this that brought computers into the general office. A word processing program lets you enter text on to a screen rather than on to paper; you can then edit the text, print it, and save it on disk for the future. Editing can involve making minor or major corrections, up to moving a block of text from one place to another or even between documents.

Spelling checkers feature in most systems and another standard application is to produce a form letter that the system can address personally to each of a number of people.

The optical character reader (OCR) is a very useful input device that, in combination with suitable software, lets the computer accept printed data from paper automatically, for storage and for further processing. Currently there are two kinds of OCR – ones which can handle only a limited number of typefaces, and those which can (in theory) read any. In Britain the more versatile type is mainly found in the academic sector, while the former is common in the office. In many contexts the OCR can save a great deal of time, trouble, and error faced by people who would otherwise have to retype an existing document. A **scanner** [42] can do the same, and also handle pictures.

Desktop publishing (dtp) [100 81] is a rapidly growing area of information technology; it can be viewed as a development of **word processing** [40]. Indeed some people predict that dtp will merge with word processing as the functions of the former become available on the latter. Until that time, however, we keep dtp separate.

A good desktop publishing system combines full feature word processing with advanced page and document layout features. Thus it lets you produce complete pages of workbooks, magazines, publicity material and so on, including many kinds of illustration, shading, boxes, logos and column features. Newspapers and other publishing companies with large computer systems have had the facility for some time, but only recently has it appeared on personal computers.

To achieve a professional finish, you must be able to output the result of your work on a high quality printer; if not, you lose much of the advantage of computerised page layout. We therefore recommend for this purpose only printers able to present complete screen images. The modern page printer (such as laser) is among those able to do this effectively and at reasonable cost. However a good dot matrix printer has acceptable output, especially if you reduce the pages with a suitable photocopier.

Though you can draw images with a **graphics package** [47] and import them into your document, a recent advance making dtp more valuable is the **scanner** [816]. This is rather like a modern photocopier; it can convert any image on paper – text or illustration – into a form you can store on disk, display on screen, edit, and print.

Concept processing [106] is currently often part of dtp packages; it aids the development and layout of thoughts intended for publication. A concept processor helps you develop and expand a general idea into a full document, adding notes and retaining any overall structure you wish at all times. The latest packages of this type actively help authors collect their thoughts. A passive **outliner** [81], on the other hand, doesn't prompt, but tends to work on the document's size of paragraphs and other surface features. Thus the concern of the first is more with the content of the piece of writing, while the second concentrates on its form.

People are now developing even more advanced tools which merge the elements of **databases** [56], **word processors** [80], and **expert systems** [53]. Concept processors of this type can extract much information from an author.

Statistical packages [99] let you analyse sets of numbers in order to identify patterns. Software of this type has grown in importance in business and in education. Today, most statistics packages not only allow you to work on your own data but have help features to explain where and how to use various statistics.

Critical path analysis (cpa) is one of the traditional management tools now available on personal computers. Programs in this class help you control complex projects that involve a number of constituent tasks, actions, and people, and to do so within a fixed time-scale.

Decision modelling [28] is a tool with a number of different techniques to allow managers to decide on one course of action from several. Such tools use cost benefit analysis, sensitivity analysis, and **critical path analysis** [43].

Image processing

Image processing [51] covers the use of IT for storing, manipulating, and transferring still or moving images. Recent advances in computer memory size and processing power mean we can use computers to store and manipulate a complete video image. Also, computers can store **graphics** [47] and **CAD** [58] images for display on screen, editing, saving, and printing as needed.

The **facsimile** (fax) [73] machine uses a long-established method of transferring images of a document round the world; it has a **modem** [59] to link it to the phone network. The original to be sent, usually on paper, is scanned (digitised) by a technique similar to that of the scanning section of a modern photocopier or a **scanner** [92]. The phone line transfers the image produced to the receiver; this has a printing mechanism like the printing part of the photocopier. Thus fax allows the almost instantaneous transfer of an image of a paper document; traditional uses include forwarding copies of contracts and of text that includes illustrations.

In recent years, fax has improved greatly, so you can send documents very quickly and accurately. It is possible to transfer the content of an A4 sheet in a dozen seconds or less (depending on the system and on how much actual information there is on the page).

With the trend towards integration of functions, personal computers with fax modems have started to replace stand alone fax machines. Such a machine can receive images sent by other fax machines and store and print them. If the computer has a scanner as an input device, it can also send out images of material on paper.

Video describes moving images created, stored, transferred, and displayed electronically. One form is television — closed circuit or broadcast video. You can transfer tv images by **cable** [17] as well as by radio waves, store them on video recorders, and **archive** [29] them on video discs.

Interactive video (IV) [50,51] involves linking microcomputers or special microprocessor-based machines to video players so the video material is under the control of computer software. This control gives direct access to the stored video images, so you can select and display at will individual still frames or sequences. The system also lets you mix the stored video images with video output (text and/or graphics) from the computer.

Video disc technology allows the presentation of individualised learning schemes. However, these packages are costly, so they are most common in industrial and commercial training departments (they often call them a medium of **computer-based training**, CBT [31]). Some firms also use IV for promotion.

Video discs can store huge amounts of information. Thus the BBC's *Domesday Project* uses IV to deliver information on demand from an immense electronic encyclopedia about the country held on two discs. In this case, however, IV is a reference resource (or information centre), rather than a type of CAL.

Wideband systems involve new technologies like **satellites** [8] and optical (or coaxial) **cable** [9] networks. Systems like these are similar in that they can carry large numbers of phone, computer, and video signals at the same time. They permit new technological applications because they can either broadcast masses of information indiscriminately or send smaller amounts to large numbers of individuals.

Many firms, universities, and colleges have wide band networks that allow **video conferences** [7], the relay of lectures and meetings, and the remote viewing of hazardous or inaccessible operations.

Satellites [8] are like central broadcast video receivers and transmitters, but in orbit around the earth. The broadcaster sends video signals to a satellite which then spreads them over a large area of the earth's surface. Currently (mid-1987) Europe has some fifteen satellites for the transfer of tv signals. Direct broadcast satellites orbit so far above the earth that the area able to pick up the transferred signal is vast: a large part of Europe for most of the satellites that serve the continent.

The main use of satellite systems is to feed **cable** [9] networks: then an individual does not need a satellite dish aerial in order to view the output.

It is also possible for satellites to relay signals between almost any two points irrespective of terrain. With a small briefcase package, you can be in video contact with someone else no matter where or how isolated you are. Satellite communication does not rely on the availability of phone lines, and will work in places that normal radio signals cannot reach. This is of course the essence of use of satellites for the navigation of ships and aircraft.

Cable networks are well known for their ability to relay broadcast tv signals to communities in aerial shadows (those unable to obtain good reception by standard means). Many more uses from the whole range of information technology now supplement this, including replacing the normal phone network with a much higher quality system.

IT AND CURRICULUM DEVELOPMENT

We now relate the IT systems described to each process of FEU's **curriculum development model** [1]. These processes are:

- *analysis of values and needs*
- *design*
- *implementation*
- *evaluation*
- *support*

We consider each in turn, looking at the possible implications of our chosen IT systems in terms of:

- the groups concerned (such as managers, LEA staff, tutors, support staff, learners)
- the action required.

We do not follow our suggestions with lists of commercial products. This is because there is, in most cases, a huge selection of items that may be of interest – and the list changes from day to day. However, we sometimes give examples (very short case studies) to illustrate the use of IT in question. Please view these only as illustrations rather than as potential contact points, though FEU will be pleased to forward specific queries if we can.

Finally, we highlight the issues you may need to discuss. These include possible short-term problems with regard to putting our suggestions into practice, as well as priorities for action.

The suggestions and objectives outlined do not concern just this research project. Rather we direct them to the FHE sector as a whole.

However, in the project's **second phase** [4.2.9], certain colleges will address some of the objectives. In many cases, they will need **support** [11.1.6] to help them carry out identified objectives, and as regards those the project is to explore, FEU (with MSC funding) will provide that support.

The second phase of the project will thus allow tutors and management to see the practical usefulness of particular IT systems in curriculum development.

VALUES AND NEEDS

The **needs analysis** [1] stage of curriculum development is not a separate entity. It relates closely to **design** [2.1] (for which it provides an essential part of the brief), and also to **evaluation** [5.1] (for which it contributes the criteria by which you can review a course).

Indeed the curriculum development model is one of a *continuous* process; thus you should review the values and needs you identify, on the basis of the evaluation of previous and current courses.

Needs analysis requires a pre-sales marketing strategy to analyse the market and to gather information from learners, tutors, industry, commerce, and the community. This information helps to establish needs and to identify values, both personal and job-related.

The process of identifying values and needs is a complex one. This is because values – social, political, economic – often differ according to environment, and depend (for instance) on each learner's background, career plan, and chosen place of learning. In turn, these values must fit in with the needs perceived by employers, tutors, and learners. Also, because each of these groups will hold different views, tactful negotiation is essential.

If the schemes envisaged involve open access and or distance learning, the design team should identify this early. They must give special consideration to it because of the heavy demand such delivery modes place on resources. Indeed, it is crucial to recognise any resource implications as early as possible.

At present, through formal and informal contacts with employers and learners, college staff investigate values and needs. Sometimes, that process may involve questionnaires and/or structured interviews.

Some colleges now employ staff with marketing skills to produce a corporate marketing plan. Certainly, in the present climate of rapid change, it is not easy to identify values of continuing relevance. For the same reason, it is hard to list long-term or even medium-term educational and training needs. It is therefore essential to develop mechanisms to increase the responsiveness of the system to social and economic trends.

As well as a great deal of activity elsewhere, the current early work in the Development of European Learning by Technological Advance (DELTA) project is of interest. This leads to the concept of a Learning System Reference Model (LSRM). The model can be of use at all stages of curriculum development to describe, monitor and assess the value of the learning that takes place. At the strategic level, it will act as a management and planning tool to co-ordinate technological progress and inputs into the educational process from industry, commerce, and the community. At the operative level, the LSRM will give clarity to (for instance) curriculum and credit transfer, course sharing, course guidance, and control.

DELTA illustrates the importance attached by the European Community to the integration of new information technology into education. It also emphasises the need for analysis and evaluation at all stages of curriculum development.

FEU's curriculum development model – which gives a clear structure to the processes involved – is a basis for DELTA. We hope that this current project, which particularly seeks to investigate how new information technologies may affect the FEU model, will be of value to DELTA too.

Information networks

Perhaps of most interest as regards **information networks** [17-80], **electronic mail** (email) [20-73] can link colleges, training establishments, and potential employers, in order to provide a firm foundation for the development of courses. As part of any pre-sales marketing strategy, you can contact industry, commerce, and community representatives efficiently using electronic mail shots. You can thus more quickly gather information about the values to embed in your courses; also you can meet deadlines on needs assessment more easily with email than with traditional mail.

Many larger databases provide electronic messaging services, the most important examples in education/training being **The Times Network Systems** (TTNS) [29] and **British Telecom Gold** (BTG) [30]. You need a **modem** [29] to connect your computer or terminal to the phone system, as well as suitable software to manage what you want to do. You will also have to pay a subscription to the system of your choice.

You may like to explore **teleconferencing** [18] to ensure you hold regular meetings and produce documents that involve submissions from all the parties involved.

A **computer conference** [19-83] on values and needs can draw a wide audience into your discussion. It lets college staff debate the need for a course with local employers without either side having to spend time and money on travel. You can consult experts from industry in order to obtain their views of the competences embedded in a particular job. You can arrange conferences between tutors and groups of dispersed students to obtain information about perceived learning needs.

British Telecom's Contertel service hires equipment for **audio conferencing** [19-84]. Also, British Telecom and several other firms sell audio conference bridges: these can handle from two to twenty lines, so you can set up your own system. Most new local electronic telephone networks (both PBXs and key units) include conference features.

Viewdata [23] has great potential as a marketing tool to raise public awareness of courses institutions offer and plan to offer. The system can provide instant information about how the needs of the community are to be met. The most accessible national viewdata systems are **TTNS** [29] and **Prestel** [23].

While many colleges and training establishments employ viewdata to advertise existing and planned courses, there has so far been little use of such systems to announce that an institution can *develop* relevant programmes.

There are several **microviewdata** [23-26] (local viewdata) packages on the market: you can set one up for access through the college network, or, with an external phone link, offer a Prestel-like service to others. Most provide a carousel mode; this lets the display cycle automatically through a sequence of pages – often ideal for marketing purposes.

Example

◊ At the University of Sheffield, Jerry Wellington has been investigating the IT training needs of a wide range of employers. To obtain information, he uses electronic questionnaires on TTNS as well as conventional methods.

Action 1

Tutors
If you are involved in planning the overall structure of courses to meet the needs of local employers and of the community consult MSC's local employer networks: these give information about the training needs of firms in the area.

If these don't suit, try information networks:

◊ to collect information about educational and training needs from learners, employers, and external agencies

◊ to publicise your institution's ability to deliver training that *is* needed.

Learners (and prospective learners)
Use information networks to discuss with peers and tutors perceived needs and the values put on the various aspects of courses.

Information centres

A number of electronic **information centres** [2, 6] act as libraries and provide up-to-date details of courses and the training establishments that offer them.

Examples

◊ **ECCTIS** [8] (the Educational Counselling and Credit Transfer Information Service) is a database housed on the Open University's mainframe; it gives details of higher education courses in the UK. POLYTEL, a complementary system, describes all courses offered by polytechnics. Both UCCA and PCAS offer electronic versions of their summer clearing vacancy databases.

◊ Guildford Educational Services have developed a further education curriculum information database. This covers the qualifications awarded by the main FE examining and validating bodies. Information held about an award includes its subject area, level, entry requirements and progression, validation, and assessment methods.

◊ PICKUP (the Professional and Industrial and Commercial Updating electronic directory) holds details of more than 10,000 short courses in the UK.

The MSC-funded **TAPs** (Training Access Points) [6] project shows an important initiative in that it uses online databases to provide information about local training provision. Unemployed people and others wishing to update their skills can obtain information about courses from computer units in the high street.

MSC has also set up CALLMI – the Computer-Aided Local Labour Marketing Information system. Using a structured format, this computerised system gathers and disseminates labour market information at a local level. CALLMI assists MSC's Vocational Education and Training Group Area Offices in understanding the local labour market situation; the information it contains can also help in negotiating with LEAs on planning training provision. The system is not networked in any way, but it aggregates local employer information at regional level.

NOMIS is MSC's National Online Manpower Information System, housed on a mainframe computer at Durham University. This supplies statistical labour market information collected on a national level, and holds all published data from the Census of Employment, small area statistics from the 1981 Census of Population, unemployment and vacancy data, and population projections. You can access the information by local authority wards, by postcode sectors, and by job centre areas. NOMIS therefore provides useful statistics for those wishing to obtain a picture of the industrial and occupational structure of an area.

A database of information about courses in the planning stage would allow colleges and training establishments to see how those responsible for education and training are responding to the needs of learners and employers. Such a database would also contain information about progression to more advanced training or to employment. In this way, innovation and information about the introduction of new courses would quickly spread.

Examples

◊ East Midlands Further Education Council aims to set up a database of programmes at the planning stage in the region. The Council hopes that this may become a national service.

◊ Cleveland County Council has initiated an information centre that collates details about courses for use by all county colleges and schools. It has a section on local employers and their training needs and provision, and one on the resources absorbed by each course given by a college.

If the information centre offers online access, you can use a viewdata package to link your terminal to the central computer housing the database. For instance, Prestel and ITNS offer all subscribers access to **ECCTIS** [8].

Action 2

Industrial/commercial managers
Refer to databases of information about the availability of courses and progression routes when selecting staff training programmes.

Managers of educational and training establishments
and
Tutors responsible for analysing the need for courses
Create, and support, initiatives towards a database of courses planned by institutions (then it will be easier to check for any potential overlap of provision).

Tutors and trainers of tutors
Access information centres for details of new methods that may make training easier, more enjoyable, and/or more cost-effective.

Computer-assisted learning

CAL [1-87] programs have received a mixed reception from both learners and tutors.

It is sometimes hard to introduce CAL into a largely traditional teaching environment, but do not overrate the difficulties. In certain situations CAL can be highly effective: it can, for instance, act as a catalyst when identifying values and needs. It is essential always to consider the value of CAL in the context of the other aspects of the course being planned, and to relate it to the needs and abilities of the learners.

Expert systems [1-76] can also support the analysis of needs. Work is in progress in Britain on a number of expert systems to help with this. Thus the Open University is designing a system to help with training needs analysis in general.

However, some projects have already shown that needs analysis is not easy to condense into a expert system knowledge base. Moreover, once you have built a prototype knowledge base, it can be a problem to prepare it for general use.

Action 3

Managers and tutors
Use *An introduction to computer-based training* (an Open University self-study pack).

Tutors and the trainers of tutors
Explore accelerated packages designed to familiarise people with the new techniques of CAL – some CAL suites are complex and require a significant induction period before staff can benefit from them.

Managers of educational and training establishments
Explore simulation and modelling CAL programs used to check you have incorporated values and needs into the structure of a planned course.

Information processing

For reasons of economy, it is wise to minimise the duplication of information gathering and handling for different purposes. In the analysis of values and needs, people will call on the same core of data for guidance, statistical, financial and publicity purposes. **Information processing** [1-77] tools allow the efficient handling of such data, making it more accessible.

Example

◊ Percival Whitley College of Further Education uses a program called *Selfi*; this covers initial data capture and feasibility studies for self-financing courses.

Action 4

Managers of educational institutions
Use the PICKUP employer database with the Dun and Bradstreet local employer directory to define targets when revising courses or designing new ones.

Instigate the use of desktop publishing for publicity material.

This latter will not supplant the production of full colour brochures and leaflets, but it will let you produce quality ephemeral and tutorial documents to short time-scales.

Managers and tutors responsible for pre-sales marketing
Use spreadsheets and decision support packages to define the financial break-even points of a potential course.

Use relational database programs to analyse the customer base for particular courses and identify gaps in provision.

Tutors
Use desktop publishing systems with concept processing facilities to outline potential course material, to let management assess the need and value of written material before a course proceeds to the design stage.

Image processing

In the area of **image processing** [1-109], new methods of communicating information support **video** [1-8] and **facsimile** (fax) [40-110]. They include **cable networks** [1-1] and **satellite broadcast** [1-2]. At the same time, fax in business is growing rapidly, and it has high efficiency in delivering promotional material. Marketing can involve almost any other communications medium: telephone, telex, **electronic mail** [1-50-20], **videotex** [1-1]. The value of the newer communications mechanisms is that they get information to management quickly.

Several companies market video cassettes that examine the needs of commerce and industry.

Example

◊ The use of video films in educational and training establishments is widespread. Few colleges, for instance, can afford to take students on visits to key firms and industries; videos are a useful substitute.

◊ Colleges now employ videos and cable networks as well as local broadcast television to market their courses.

Action 5

Managers of educational and training establishments
Advertise on community cable and broadcast television, covering both the complete prospectus of your institution and individual courses.

Issues

IT should stimulate closer links in the curriculum development process between analysis of values and needs and the design stage, feeding greater structure into course design.

Since IT systems permit more rapid feedback, closer links will appear at management level between needs analysis and evaluation and review. As a result, these two phases of curriculum development are likely to merge. They will become a continuous process, carried out by a team or committee charged with maintaining the standards set for a given course or for the establishment as a whole.

If the application of IT to the processes of curriculum development causes these to merge, tutors will more easily be able to envisage the curriculum development cycle as a whole.

Consequently, in the areas of support and staff development, there will be less need to impress upon tutors the relevance of course components. This is because they will see for themselves how the training meets the values and needs identified in the first stage.

Priorities

Clearly, it is easier to achieve some of the objectives identified in the action boxes than others.

Hardware, software and familiarisation costs may act as a deterrent, and institutions will need to review their available IT resources to decide if they can put them to more profitable use in the light of our suggestions.

In some cases, local circumstances may militate against successful implementation. For instance, in an area of inter-college rivalry, a scheme to introduce a database of planned courses may prove unwelcome.

Some applications described in this section are of greater importance than others. For instance, it would be of great benefit if, in the development of courses, the stage of needs analysis more closely linked to past and present student assessment. If you can demonstrate to employers that the identified education/training needs relate to assessment, the employers would better appreciate the status of profiles.

COURSE DESIGN

Examining bodies often determine the **design** [3c12d] of a course centrally. However, with the trend to modularisation, learning and training establishments may become increasingly responsible for this work.

Designers should ensure they negotiate the content and structure of the training with employers and/or students. It is important that the target group accepts the course, and that access to it, and progression from it to other qualifications, are clear and attainable. This stage therefore requires co-ordination, both within the design team itself and between the team and external agencies.

Needs analysis [3c] provides the basis for the design stage. The function of the latter process is to translate identified values and needs into a framework or strategy ready for **implementation** [1122].

For instance, BTEC programmes in electronics shape the needs of electronic technicians into a programme that provides a fundamental framework for the implementation of the training; this takes into account rules concerning attendance, location, resources, choice of options, methods of student assessment, and the evaluation of the course itself.

In the same way, YTS courses have a work-based strategy; their designers must plan for on the job learning during implementation.

The design process may take different forms. Sometimes it may rely on the efforts of an individual tutor; more usually, however, people work in a team with a specific allocation of resources. In either case, people from outside may provide extra help.

Traditionally, committees have managed the design stage; discussion has been the main method of proceeding. IT can help in various ways, for instance by facilitating communication and by helping design teams identify available resources.

Information networks

Among **information networks** [17 60 125], perhaps **electronic mail** (email) [20 21 129] is the most useful means of communication between members of a design team based at different establishments or on different sites. Assuming adequate access to the hardware and software involved, they can make connections at any time of day (or night), with mail received (even if not read) almost instantaneously, and sent as easily to a number of people as to one. Access *is* a problem at the moment though, for not all FHE centres subscribe. Even those that do may not yet have set up a proper system of frequent access and passing on messages.

Electronic networks also provide a bulletin board facility: you may display messages, notices, and other information to groups. The value of **chat mode** [19] can sometimes justify the heavy phone call charges.

Example

- A number of universities have employed electronic mail internally to allow courses to develop in collaboration.
- Newcastle Polytechnic's law department uses Newcastle University's electronic mail service to allow staff to work together on courses.

Viewdata [23] systems (particularly TTNS and Prestel) offer information from many sources that may be of use to course designers.

For instance, tutors planning a tourism module might explore Prestel's tourist advice sections and railway timetables; there are many other such examples, for academic as well as for vocational courses.

Telesoftware [24] involves **viewdata** [23] storage of computer programs and text for downloading into a receiving micro. Course designers producing print materials and software can send drafts to others this way to evaluate and correct.

The **computer conference** [19 61 128] can be an important tool in the design of a syllabus. It lets colleagues promptly receive, acknowledge and react to documents transmitted by **electronic mail** [20 60] to the whole group. Each recipient can easily edit the material on a word processor, and thus avoid copy typing errors. The role of the chair or project leader changes very little; however, computer conferencing removes many of the restrictions of time and space. All the same, it may be important for the group to meet occasionally in one place.

Examples

- Southampton Institute of Higher Education uses *Participate* to convene a business studies IT user group.
- The Open University uses CoSy in a number of such contexts.

Audio conferencing [23 129] is easy to accept as a tool in curriculum design. The medium is of value for bringing together members of design teams from different educational and training establishments. It can also help in obtaining specific information from experts and employers, without the cost and disruption of travel.

An audio conference requires less hardware than **computer conferencing** [19 61], and group members are more likely to reach a decision when communicating live this way.

The most comprehensive trial of educational audio conferencing so far undertaken in Britain involved the Plymouth Audio Conference Network (PACNET). A review of the PACNET experiment (which ran from 1984 to 1986) concluded that the technique needs to be incorporated or embedded within the course itself for greatest impact.

Audio conferencing is not, therefore, a medium for the ad hoc meeting without a known agenda. CET reports that PACNET users were pleased with the savings of time and trouble, impressed by the efficiency of the medium, and convinced that the phone conference is a useful adjunct to traditional meetings.

However, not all applications were suited to this approach. For instance, those demanding a high level of transfer of visual images or complex mathematical equations may need **video conferencing** [26] or **audiographics** [129] to meet their needs fully.

Examples

- In Britain, the Open University has most experience of audio conferencing in course design.
- At North London Polytechnic, Dr Noel Heather has used the medium for bringing together expertise from a range of higher education institutions.
- Top management at Gloucestershire College of Arts and Technology set up conferences using their **pbx** [61].

Action 6

Course designers
Use information networks to communicate with, and to receive inputs from, outside experts and employers, to help you identify appropriate uses of the various methods of networking.

Information centres

Information centres [37 or 38] (electronic networks) can provide access to large **databases** [39] of searchable information.

Examples

- ERIC – abstracts from the US Educational Resources Information Centre.
- BLAISE, the British Library Automated Information Service.
- **ECCTIS** [63], the Educational Counselling and Credit Transfer Information Service (access through Prestel or TTNS).
- ResCue – an online database of educational resources maintained by the Regional Curriculum Bases (accessed via TTNS).
- FEU's *Directory of courseware for FHE* (accessed via NERIS, the National Educational Resources Information Service, in turn accessed through Prestel Education).
- MARIS, which provides details of open learning materials, particularly for training.
- **TAPS** [64] – a local online database scheme providing information about access to training.
- *IT and Education*, run by ESRC at Lancaster University, covering all research activities in the field (access through **JANET** [20]).
- The MSC library database, designed for use by MSC staff to carry out literature searches and as a current awareness service.

Some database providers cannot offer online access, but will carry out searches on request. This applies to:

- CET's database of research projects in IT.
- FEU's database of ESG-funded courseware projects.
- ALBSU's database of resources for adult basic education.

Library staff can usually carry out searches of international databases such as BLAISE, DIALOG, and ERIC. In the future, such searches will be open to others and less costly. This is partly because large databases will appear on **CD-ROM** [28] – computer-readable compact discs which you can search off-line. Already ECCTIS is available this way.

Examples

- Hartlepool College of Further Education uses TTNS to advertise its open learning materials.
- Fareham Technical College has produced an online college prospectus.
- Percival Whitley College of Further Education uses an **authoring language** [40] to produce its computerised prospectus. Sent to schools and firms, this runs on the BBC Microcomputer.

Action 7

Course designers
Use online databases to obtain information on relevant work in a given area and details of existing courses.

Managers and public relations departments of colleges and training establishments
Take steps to initiate the electronic advertising of the types of training the institution can provide.
Use existing networks wherever possible, as this will increase the number of accesses.

Computer-assisted learning

CAL [66] has the potential to be an important resource for learning in almost any area of education and training.

Course designers must take into account the social and emotional needs of learners. The conditions for personal development are not easy to identify; however, you are more likely to find them in face-to-face situations than in the more austere forms of CAL, are much less personal.

There are, of course, many ways of using the technology for support rather than to substitute for traditional teaching modes. When choosing or designing a CAL package, you must take into account its likely context(s).

If training is to involve student use of CAL materials, plan for this right from the design stage. For CAL to be a successful tool, you must integrate it into the courses that use it. Thus, at an early stage, the design team must review potentially worthwhile available packages; if they find these unsuitable, they may wish to write or commission such materials themselves.

A number of FEU Regional Centres, some receiving Education Support Grant (ESG) funding, now have expertise in the production of courseware for further education. Consult your nearest centre in the first instance, since they may be able to commission the required package or to advise on its production.

If a design team has only limited programming support, there are several **authoring** [136] languages and systems on the market that can help non-experts write their own CAL packages. FEU has set up a research project (RP 385) to produce helpful guidelines on this.

However, many CAL packages produced with an authoring language are unsuccessful. This is not so much due to the limitations of the authoring languages themselves; the writer(s) must have adequate experience in software design – a new and tricky field.

Thus the design team may need considerable staff development before they can feel at ease with these skills. This takes time, so it is best to limit authoring languages in early days to the simplest uses. Perhaps this should always be the case when the design team consists solely of subject experts working in their own areas.

CAL has had a complex impact on the processes of curriculum design. However, we accept that it offers new and exciting possibilities for:

- ◊ improved cost-effectiveness;
- ◊ the individualisation of learning;
- ◊ increasing the richness of learning;
- ◊ increased motivation in the students;

A danger is that CAL also increases the motivation of some tutors and course designers to experiment with new technologies without due regard for their appropriateness. Certainly many packages are outcomes of the question 'How can I use CAL?', rather than of 'Where should I use CAL (and where should I use other media)?'

At the design stage, the availability of CAL and of **interactive video** (IV) [50 111] can and should have a major impact on the formulation of aims and objectives.

When we devise objectives for a piece of learning, we inevitably suffer from the constraints of what we know we can teach and what we know we can measure. The new technologies can have a catalytic effect, in that changes in the curriculum and in learning methods may take place once tutors become aware of the potential of the new systems.

As with needs analysis, the more detailed aspects of curriculum design can benefit from the systematic approach imposed by CAL and IV. The ordering of topics, the routes between them and the definitions of different pathways through the material for different kinds of learner all make designers think about what they are doing, and why.

Computer-managed learning (CML) [34 137] lets you build into package design the means of obtaining feedback from various modules or lessons. In this way, you can find out more about how students learn and their general views about a particular course. If you see CML as helping with student assessment, you must plan for this too during design.

If profiling is part of the assessment, the design plan must fully specify the course's intended learning outcomes and consequent profiling sentences.

Examples

- ◊ A pharmaceutical company decided to introduce CAL into their introductory course for sales representatives. During the design stage of the package, they discovered they had to restructure much of the existing training. The result was a more efficient programme.
- ◊ You can obtain a sampling of the expertise of colleges in designing CAL and in using authoring languages by asking FEU's Courseware Unit to carry out a search of its database of ESG courseware projects in particular subject areas.

As far as using **expert systems** is concerned [114 136], we need a better understanding of the learning process, and we need a language to describe it. As no one has yet filled those needs, there has been some lack of questioning of the value and validity of material produced by teachers, and (as a corollary) a teacher-dominated curriculum.

In addition, we cannot easily diagnose errors made by learners or tutors, let alone anticipate them. No doubt, ideas and techniques from machine learning and knowledge engineering will eventually reduce these problems.

We can use expert systems to clarify a subject, in order to determine what topics are most important in relation to the aims of a training package. For courses assessed by profiling, the knowledge base produced will also help determine the required profiling sentences.

Examples

- ◊ Oxford University set up an interdisciplinary research project in 1983 to specify and implement an expert system in Scottish divorce law. Researchers claim it is already clear that current expert systems in law will be of great use in teaching the subject.
- ◊ Kingston College of Further Education is developing starter packs to assist staff in introducing expert systems to their curricula.

Action 8

We can recommend no specific action in this area, since the use of CAL and expert systems in the design process is at a very early stage.

In general, however, *managers and tutors* should be aware of likely rapid progress.

Information processing

In the context of **information processing** [5, 7, 12], if the course involves teaching **relational databases** [27, 41], or if students will need them to access resource material, the design strategy must take this into account.

Example

- ◊ East Herts College is integrating the use of the database *Superfile* into foundation level BTEC work across the curriculum. This has involved the design team in the production of student materials, the creation of sample databases, and so on.

A good use of a **spreadsheet** [28, 34] is for costing a curriculum project. This should enable leaders to run their projects more efficiently and cost-effectively. Spreadsheets will also feature in the design process if students are to learn how to work with such programs.

If you intend students to learn to use **statistical packages** [33, 43], your course designers will need to select suitable software and write assignments round it.

The advantages of using a **word processor** [40, 44] to draft documents are well known. More sophisticated word processing programs have database facilities that let you search files or rough notes while composing a text.

With **desktop publishing** (dtp) [42, 106], you can use the same hardware and software for every stage of document production or revision, including preparing rough drafts, creating quality artwork, and laying out the final version. Authors and secretaries at their own desks can undertake all the work, relying little on others for design, typesetting or printing. This can cut costs and time-scales dramatically, compared with conventional publishing methods or with hybrid arrangements. (Those last include passing a disk from a word processor to a printing house that can typeset from disk.)

However, dtp is a tool that one can abuse as well as use. In order to obtain pleasing results from such software, staff training is essential; staff also need to have an eye for design and page layout.

Desktop publishing is among those IT tools that make collaboration between team members very easy.

Planning aid programs that let the user structure documents hierarchically can further enhance communication between team members. As a result, it becomes easy to produce printed copies of selected views of a document, perhaps for distribution to sub-groups within a team.

One example of the selective view could be a list of specified aims and objectives together with relevant pages from the main text (including worked examples). For instance, you can depict the contents of a draft as a tree; each component (such as a section heading) can carry with it information like its dependence upon other components, its required date of production, and the number of words or pages or pictures allowed for it.

Such programs can help a team reach a consensus faster on such matters as:

- ◊ which major/minor topics to cover, and why;
- ◊ what each topic involves (definitions, applications, and so on);
- ◊ whether, and how, a given topic links to others.

- ◊ how much teaching time and how many pages to devote to a topic;
- ◊ how to introduce a student to a topic (broad decisions on teaching strategies);
- ◊ how to implement decisions on teaching strategies (such as incorporating worked examples, summaries, and aims);
- ◊ how to derive assessment material from text;
- ◊ how to deal with peer and student feedback when revising material;
- ◊ how team members will share the work.

Word processors, dtp and planning aids can therefore help to bring a training programme up to date by cutting the time needed for the task.

Desktop publishing can aid two kinds of evaluation prior to course implementation: **critical commenting** [ ] and questionnaire-based try-outs with learners (**developmental testing**) [ ].

In critical commenting, you send drafts out to people familiar with the subject area and with typical learners. They read through the material and then comment on its probable teaching effectiveness, suggesting suitable changes. They need a checklist that covers the clarity and adequacy of study guidance, definitions, and exercises; the time learners might take; and the problems learners might have with particular sections or exercises. They also have a checklist for content. Such testing is often carried out with typed drafts, double spaced to make it easy to add annotations.

The user of dtp can produce two versions of a draft automatically. A fairly polished, double-page one is laid out much like the final published material (so a more realistic response would follow); the other is double-spaced for annotation, and can carry various additions (such as selected questions from the checklist, printed opposite relevant parts of the draft).

Alternatively, you can send critical readers a fair copy plus a version on disk; they then comment directly in the disk file and return it. Making comments on disk this way is becoming quite common.

In developmental testing, drafts go to people who are as much as possible like those who will study the material in earnest. Each draft comes with a questionnaire.

The draft has room for testers to make unsolicited comments as they read. It also contains specific messages at places of interest to the author, referring testers to particular questions on the questionnaire. Such questions might invite testers to react to a particular paragraph (on, for instance, its clarity and perceived relevance), or to note how they got on with an exercise.

With the powerful word processing programs used in **desktop publishing** [42 to 44] suites, it is easy to assemble a questionnaire quickly from a stored bank. Similarly, you can bank the special prompts, and add them to drafts as needed, removing them just as easily after testing.

Integrated software packages have limited **graphics** [to] capabilities. They may or may not suffice to introduce students to ways of expressing quantitative information graphically as an integral part of teaching a variety of business-related skills. You may therefore need to explore their potential during course design, comparing them with stand-alone graphics systems.

Optical character readers (OCRs) [41] and **scanners** [42] are useful input tools for aiding curriculum development if the members of a design team have to work on different computers. They allow users easily to enter into their machines externally generated graphics and text for study, storage and editing. Using OCRs and scanners also lets you produce student materials from printed sources without rekeying, though copyright restrictions are of course relevant.

Example

- ◊ Oxford University has used its OCR to input accountancy material so that students elsewhere can access it by terminal.

Action 9

Course designers
Use information processing tools, such as relational databases and spreadsheets, to generate and maintain materials and to cost the design process itself.

Managers of educational and training establishments
and
Tutors
Use dtp to create publicity material for the completed course.

Image processing

As far as concerns **image processing** [ ], **graphics packages** [ ] play an increasingly important role in **computer-aided design** (CAD) [ ]. They also have a place in industries outside the engineering and science areas. Examples are the computer-aided design and manufacture (**CAD CAM**) [ ] of fabrics, and modelling for environmental and architectural design.

Graphics packages also find a useful support role in teaching various students right across the curriculum. One general area is that of **CAL** [ ], in which graphics often play a prominent part. Consequently, course designers will often need to make appropriate use of graphics packages.

Facsimile (fax) [ ] machines are of great value for the transfer of prototype designs, graphs, and flow charts between geographically dispersed members of the design team, to allow for possible alterations. You can also use them to circulate materials to members or to outside experts for discussion at an audio or computer **conference** [ ].

Interactive video (IV) [ ] is costly to produce, and often involves complex problems of copyright. The production of an IV package requires a team of experts and, generally, outside funding. However, there are a few video discs available, and various IV projects are in progress. If a course is to have an IV component, this will be a major concern at the design stage.

NIVC supplies current lists of available interactive video packages.

Examples

- ◊ FEU set up three projects to investigate IV's potential in further education; all three have now produced reports, and summary bulletins are available.
- ◊ Several colleges are actively working on producing IV disc or tape packages. Among them are Brighton Polytechnic, Brighton College of Technology, and the National Centre for Computer-Assisted Language Learning at Ealing College of Higher Education.
- ◊ The University of London audio-visual centre has done extensive work in this area and produced discs on anatomy and law.
- ◊ The Interactive Video In Schools project, funded by the DTI, has produced eight programmes, piloted in schools in 1987.

Action 10

Course designers
Relate the content of a course to appropriate image-processing methods.
Use IT tools to transmit and receive information about image-based materials at the design stage.

Issues

In cases where different people are responsible for needs analysis and for curriculum design, electronic networks greatly assist communication. As a result, the final design strategy will be more responsive to the needs of learners, employers and the community.

It seems likely that with the introduction of The Open College, information networks and information systems will play a growing part in course design. The Open College is to employ IT systems to deliver courses, and designers will need to take this into consideration.

The more difficult a course is to design, the more problems will occur and the more the design team will need to consult. Again, IT can assist. Colleagues may discuss issues without necessarily fixing a meeting in one location, and thus achieve savings in both time and money.

If the course requires the development of learning materials, whether computer- or paper-based, various IT tools can help. If materials are stored electronically, it will be much easier to carry out any subsequent revision. Desktop publishing systems in particular allow course materials to be maintained and updated more cheaply than if they need to be reprinted by traditional means.

The relationship between the design and implementation stages of curriculum development involves difficult decisions. For instance, how much detail should the design team decide, and how much leave to the judgement of individual tutors?

IT systems facilitate communication between the designers of a training package and those who will deliver it. Post and phone each has disadvantages that electronic mail, for instance, overcomes.

Tutors can report unexpected problems as they occur, and receive appropriate advice. Similarly, one tutor can communicate individual successes to all teaching the course, and incorporate the details into the general plan.

It may also be that, in the first instance, an individual tutor can have more freedom to interpret curriculum design, since you can arrange regular support and guidance with IT networks can be arranged.

As IT systems allow more easy feedback from students, tutors, and external agencies, there is an opportunity to specify a design plan that follows proper negotiation and is acceptable to all.

Priorities

In practice, some objectives outlined in this section are not feasible at a reasonable cost (not yet anyway). Managers must carefully review available resources and cost staff development as well as hardware and software purchase.

However, despite current practical realities, it is a useful technique to give imagination a free rein without the constraints of our inbuilt censor to tell us to keep quiet about ideas thought to be out of the question. This exercise is valuable in the design stage of curriculum development, and brain storming sessions let it happen very effectively.

The responsiveness of educational and training establishments is now an important issue. IT can help institutions modernise curricula more quickly, and thus increase the attractiveness of programmes to students.

Institutions also have to cost their activities with care. This is the subject of the MSC's Joint Efficiency Study (JES). The JES has published papers which tutors can consult.

This report does not deal with institutional management. However, it may be appropriate for the design team to consider the unit costing of courses. Computer-based packages can help in this exercise, and several institutions (including Percival Whitley College of Further Education and the Open University) have experience in these areas.

A growing number of colleges and training establishments have access to electronic networks. Controlled use of electronic communication is not costly. As outlined above, it can even save money otherwise spent on travel, and it allows staff to spend their time more efficiently. Electronic communication also lets tutors obtain support cheaply from outside experts. Design teams should use communication networks wherever possible, to share expertise and to minimise duplication of effort. In this way, they will come to identify appropriate uses of the various methods of networking.

Most agree that future work needs to focus on integrating these various methods. We also need research into the potential of using information networks in conjunction with other IT tools.

It is therefore important that staff communicate their experience of using the technology. They may disseminate this information using electronic networks as well as by traditional means.

Desktop publishing, on the other hand, is still fairly costly; establishments need to consider whether they have the volume of work needed to make the purchase of a dedicated system economic in the long run. A useful halfway stage is to purchase a dtp package for a general purpose computer and develop its use within existing hardware system.

Another factor to consider is whether there is a member of staff with sufficient expertise to operate the system. Unless the user has a eye for layout and design, the end product will be unsatisfactory, no matter how powerful the system. Sometimes it is best to leave the job to the professionals!

One thing is clear. Whatever IT systems are used, design teams will need training in their operation, and adequate technical support thereafter.

IMPLEMENTATION

The **implementation** [11] stage of curriculum development is essentially the organisation of learning. The process is a labour-intensive one: each course entails a number of staff-student contact hours, and many more of preparation and marking.

Tutors implementing a new programme need to identify appropriate teaching and learning strategies, and to consider their mode(s) of delivery. The style can range from traditional didactic lecturing to almost complete learner autonomy. In that latter case, the learning experience can be self-directed, self-paced, and even self-accessed.

However, if tutors are to support the training, they will need staff development to help them adapt the course specification to their own style and circumstances.

There will be a need for even more staff development if IT is to be one of the teaching tools, since the role of the tutor may change – and, in any case, the tutor will need to acquire new skills and strategies, or to modify existing ones.

Implementation is essentially a follow-through of **design** [7.1.3]. However, tutors have a degree of choice as to how to cover the course. They may need to alter or develop the materials, and to check that resources (including new technology) are available. If necessary, someone will also need to brief and retrain support staff.

At the outset, learners may need guidance on whether a particular course provides what they want. From the start too, the tutors must agree the method(s) of assessment, for they will need to monitor the progress of those who take the course, even if not in a formal way. The tutors will also plan the evaluation of the course itself, so they can make best use of feedback.

Clearly, many of these issues must be raised in both the **needs analysis** [7.1] and the **design** [7.1.3] stages.

Information networks

Electronic mail (email) [2.6.6/7] is a most exciting aspect of using **information networks** [2.6.6/7] to support delivery; with it tutors can see new technology as an aid rather than a threat.

In general, new technology allows curricula that have long been desirable now to be possible. IT's potential to enhance the curriculum is perhaps most obvious at this implementation stage.

An electronic network helps improve teaching learning strategies by the sharing of resources. Also:

- messages between groups of young people in different centres can break down barriers due to prejudice or remoteness;
- groups of trainees in different centres can share assignments by means of electronic mail;
- student enquiries to industry and commerce may receive replies in time to include them in project or assignment evaluation (indeed the speed of response is a great motivator here!).

Examples

- The Hampshire Information Technology (HIT) project uses electronic mail to distribute spreadsheet courseware to colleges in the Authority.
- The **ResCue** [8.5] electronic network distributes pre-vocational student assignments by electronic mail anywhere in the UK.

Viewdata [2.5] contains much information of use on a variety of courses. It is easy to prepare assignments that involve students searching **Prestel** [2.5] for train times, exchange rates, food prices, and so on. On the other hand, it can be costly to allow them to learn about viewdata systems by working online.

Various **local viewdata** [6.2] systems allow the creation of a centre's own viewdatabase for teaching purposes. They do not need a phone line, unless they are to include frames captured from Prestel or they are intended for people elsewhere to access.

Tutors may also use viewdata, locally or otherwise, as an electronic blackboard, or for display (perhaps to advertise a course). There is wide use of local viewdata packages in the classroom to foster communication skills.

Examples

- The Association of British Travel Agents' computer-based training project has integrated viewdata into the training of travel agents.
- CET has produced eight training modules on Prestel designed to help travel industry staff make more effective use of the various systems and services operating in the industry.
- Dudley College of Technology runs an educational viewdata service as part of an Education Support Grant project. The database offers a free public access service simulating a business system linked with BTEC-style student assignments.

Telesoftware [2.4] allows you to download computer programs from (for instance) Prestel Education and from the BBC's Owltel service. There is also telesoftware on **teletext** [2.4].

Computer conference [page 36] systems can help deliver the curriculum, especially in distance and open learning contexts. It is also of use if there is a shortage of tutors in a subject area or there are too few students wishing to take a course to make it viable if taught conventionally.

Examples

- The Hampshire Information Technology (HIT) project delivers an online interactive course in information networking. Six online sessions run between two face-to-face sessions, one for initial training and one for final evaluation.
- Newcastle Polytechnic tutors have taught an integrated law and accountancy option to final year students on a BA Accountancy course using computer conference. It has proved advantageous to work with a small number of participants to begin with. Tutors find that the medium permits the efficient use of time and resources. It concentrates the learner's mind and gives greater incentive for producing high quality work — since it is in effect published rather than merely handed in. All the learners have some hands-on experience of computers. However, it is clear that the medium brings a danger of demotivating those without keyboard skills.

The Open University is the main educational user of the **audio conference** [page 34] in Britain. The extent of its use in the implementation of courses varies according to the requirements of particular subjects.

The Open University has also led with experiments on the educational use of **audiographics** [page 34] through its now discontinued Cyclops system.

Examples

- London University has carried out a series of experimental audio conferences for students, involving the Department of Extramural Studies, Birkbeck College, and the Royal Veterinary College (RVC). A preliminary face-to-face session precedes each conference. In the conference organised by the RVC, participants received preparatory work.
- The University of Wales' College of Medicine (UWCM) runs courses involving audio conferences that they have structured with care. These are for groups of students concerned with highly specialised subjects. When the district teaching centres connected with UWCM call on audio conference, it is mainly in conjunction with a range of audio-visual facilities. These include video tapes to be viewed before sessions, and slide sets the students can follow during the conference. Tutors see audio conferencing as a useful method of providing linked tutorials to allow discussion between groups of students as well as interaction with the tutors.
- Cornwall College of Further and Higher Education also use audio conferencing as part of the 75% distance learning element in a diploma course in acoustics.

Tutors agree that audio conferencing is best for group discussion rather than for lecturing, and that the medium calls for careful structure and planning. The preparatory work is a discipline for students. Also the audio conference encourages them to complete work on time — silence during the conference implies failure to have done so. The technique is also extremely successful when integrated with written and other support materials that provide a context.

At the same time, audio conferencing is an interactive medium with an element of drama that requires tutors to work in a new way. This can be highly motivating. The relative anonymity of the system may encourage contributions from learners who would be reluctant to participate in conventional meetings.

Tutors can achieve a great deal by linking audio conferences with other educational media in the context of a clearly structured curriculum. Researchers seem satisfied that the medium is cost-effective. However, it is worth noting that two of the most enthusiastic teams involved in distance learning by this means (other than the OU) handle subjects whose practitioners are highly paid: medicine and veterinary science.

The **video conference** [p3] is another useful means of instruction if there are so few available tutors in a particular subject that they need to handle several groups of learners, often at more than one location. It is, however, costly in terms of equipment.

Examples

- London University has linked several colleges by means of a video conference system called *Livepost*.
- The Welsh universities are installing a similar system so they can instruct more students using Welsh.

Action 11

Managers, tutors, and students
Explore the cost-effectiveness and potential efficiency of installing or subscribing to information networks.

Tutors
Use information networks in various ways, for instance to:
- download software
- market new materials and curricula
- share scarce resources among a range of students

Students
Explore the opportunities offered by computer- and audio-conferences.
Develop appropriate communications skills in order to derive maximum benefit from such media.

Information centres

There are many **information centres** [270-288]. Students as well as tutors should have access to online **databases** [29] – perhaps even **BLAISE** [65] and **ERIC** [63] – in order to carry out research for project assignments. Not only does this widen the range of source material available to them, but it gives familiarity with the use of IT systems.

Tutors may also find it useful to put book lists, handouts and questions on an information centre accessed via a resource centre or library. Such information can easily be updated, and learners can take their own copies on demand (thus saving reprographic costs).

If such a database permits online access from remote terminals, it would have particular value for distance and open learning.

Action 12

Managers
Explore the feasibility of providing staff and students with general access to online databases.

Tutors
Offer support for this by putting material into electronic resource banks.
Prepare assignments that encourage students to search the databases for information.

Computer-assisted learning

Many **CAL** [31-39-166] packages can be bought off the shelf. FEU's *Directory of courseware* and other educational reviews give some indication of market, quality and usefulness.

It is important to realise that many CAL packages make new demands of the learner. For instance, some tutorial suites demand high levels of concentration, so you should limit use to about twenty minutes at a time. In such cases, it is best to structure the material into short modules.

CAL software also makes new demands of tutors. They are no longer the major source of information, so their role changes to that of adviser and manager of learning and resources.

Tutors may find they need to produce additional paper-based materials – such as worksheets and additional instructions for use – to support CAL programs before students can use these successfully.

Packages produced in-house using an **authoring language** [49] are presumably already tailored to local needs. However, tutors must always try to ensure that the CAL material they write or choose for use exploits the potential of the medium to:

- individualise learning;
- motivate learners;
- obtain feedback.

Some commercial **computer-managed learning** (CML) [39-40-41] programs can assist tutors with profiling, if this is among the means of student assessment.

Examples

- Firms have employed computer-based business games for many years to reproduce situations they could not otherwise use for training. Thus Austin Rover has set up open learning centres to provide employees with a computer-based and managed learning system in the car industry.
- Among institutions that have made use of computer-managed learning software are Brighton Polytechnic and Garretts Green College (Birmingham). The latter's work is for adult preparation training (APT) certification.

Expert system shells [179-180] are a useful tool for both staff and student use in the implementation stage.

It often seems that those who benefit most from expert systems are the people who examine the basis of their understanding and reformulate it for incorporation into a knowledge base. This forces them to make explicit their conceptual beliefs, and to explore the reasoning behind their knowledge.

It is therefore likely that learners could derive much benefit from building their own expert systems. Such an exercise lets them clarify their understanding, and promotes discussion of topics they find hard to grasp.

In addition, the tutor receives prompt feedback about student reaction to the syllabus content, and can alter teaching strategies if need be.

In some subject areas, tutors may find it appropriate to build their own knowledge bases; they can then offer these as a learning resource.

Such a resource requires careful planning at the curriculum design stage. However, the process of encapsulation of expertise need not stop when the expert system is set up: its rules, as well as the examples from which it generates the rules, should be available at any time for inspection (and even for possible amendment by each person who works with it).

An expert system designed in this way can systematise the accumulated knowledge of its users, eventually reaching a level of expertise much exceeding that of any single one.

Examples

- ◊ Kingston College of Further Education is working on a starter suite of expert system packages for non-advanced further education.
- ◊ The Exeter University School of Education is applying logic programming and expert system approaches to the humanities curriculum at secondary and NAFE level.

Action 13

Trainers
Explore the possibility of enhancing the curriculum by using CAL packages with students, whether off the shelf or produced in-house with an authoring language.
Use expert system tools in a classroom setting to clarify the understanding of a topic within a group.

Information processing

In the area of **information processing** [35 97 172], **relational databases** [39 97 189] have a proven value in many different teaching/learning situations. Learners can construct their own database, or work through exercises that involve the use of a commercial example.

New packages in this category, such as *dBASE III*, also let you carry out statistical analysis. Tutors can use such databases to store and process examination results, for instance.

Examples

- ◊ East Herts College of Further Education is piloting learning materials based on *Supertile* with foundation level BTEC students.
- ◊ Many social studies and pre-vocational departments use *Quest* for elementary assignments based on census information and surveys, for instance.

It is not hard to integrate **spreadsheets** [36 98 189] into the curriculum across a range of subjects – their use is not only for business-related topics. Thus, social studies departments use spreadsheets for the analysis and costing of community programmes, while science departments find them of value when exploring the results of experiments.

Integrated packages (such as *Lotus 1-2-3*) also allow statistical analysis to be carried out from spreadsheets.

Example

- ◊ Norwich City College of Further and Higher Education has introduced spreadsheets for computer-assisted learning within non-advanced further education.

Statistical packages [44 93 172] are of wide use in humanities as well as in science and mathematics departments. However, the availability of appropriate hardware is a crucial factor. Most statistical programs for micros are for IBM-compatible systems, though there is a fair number for the BBC machines.

Spreadsheet [143] software may become more widely used for elementary work in this area when the statistical feature becomes standard.

Example

- ◊ Apart from the obvious uses of statistical packages in mathematics and the sciences, as well as with BTEC and similar students, social studies departments often employ them to analyse census material.

We wish to encourage tutors in all subject areas to integrate information technology into their work where appropriate. Partly this is because most students will need to operate computers (or at least be aware of their potential) when they enter adult life. Thus there is a strong demand for almost all leavers to have keyboard skills. Many would like to produce assignments on a **word processor** [40 190], and this should be encouraged – but this will have implications for the institution's computing resources and there may be the question of plagiarism.

However, many people feel that word processing is the best way into information technology both for tutors and for learners, so you should think hard about this approach.

Students on journalism, business studies, computing, and media studies courses will need training in **desktop publishing** [42 106 172].

Sophisticated word processing packages often incorporate database facilities. These help learners who keep their notes on disk to organise their material for revision purposes.

There are also systems on the market that may help improve writing style in various ways. They can check the surface features of a text (including readability, sentence and word length, sentence type, and word use). If the elements of good style reside chiefly in elegant variation of vocabulary and sentence length, such packages may have their uses.

Learners who find it hard to structure written assignments may benefit from **planning aids** [101] – programs to help them organise their thoughts into logical sequence.

Tutors can save time and improve the presentation of handouts and worksheets by producing them on a word processor. Word processing is especially valuable if the material is to be used in successive years, because disk storage means it is easy to update.

Currently, the inclusion of **graphics** [37, 100] packages in the curriculum depends mainly on two factors – the needs that result from specific applications in industry, and personal interests among staff teaching a variety of subjects. In terms of the divide between pure and applied art, the practical demands of industry mean that the emphasis is increasingly on the latter.

Graphics programs extend the idea of word processing to illustrations and even to complete pages (since you can think of page make up as producing page-size pictures which happen to include text). You can use graphics software to edit artwork from outside sources (for instance, **scanned** [42] versions of photographs, which you can then enlarge or otherwise alter electronically). Such programs are mainly of use for creating illustrations, so are useful in all contexts, not just for courses in communications, media, and art and design.

Examples

- ◊ Ealing College of Higher Education offers a BTEC HND course in business and finance (media, design and communication studies); this includes initial and advanced work in computer graphics. Learners begin by familiarising themselves with basic techniques using BBC Master machines, before moving on to a more advanced system. That used at Ealing is Image Artist, a hardware/software package used with a variety of input/output devices but geared specially to slide production. Student work includes the production of slides for incorporation with video. An interesting development has been an association with the **cable** [34] tv service set up in the area (CableTel). Educational programming languages such as *LOGO* have also played a part in introducing the use of computers in art and design.
- ◊ A more advanced course runs at Dorset Institute of Higher Education. This BA(Hons) programme in communications and media production involves teaching sufficient programming skills to allow students to use library sub-routines.

Action 14

Managers
Encourage and develop a unified approach to access to and use of these diverse packages.
Ensure adequate staff development and INSET across the curriculum and in support areas.
Demand an adequate supply of trained support staff.

Tutors
Become familiar with available packages in order to recommend appropriate purchases and to teach students applications.

Students
Take on more responsibility for learning.
Acquire important new skills.

Image processing

In the field of **image processing** [47, 100, 139], at present commercial and industrial training establishments use **interactive video** [20, 21, 100] more than FHE colleges. This situation is likely to change as more video discs become available, and the BBC's *Domesday* package and the IV In Schools project are sure to speed up the introduction of the technique into FE.

Examples

- ◊ The University of Nebraska College of Law uses IV to present a realistic trial situation. The student acts as the defence attorney in a trial and, through the computer software, affects the direction the trial takes, depending on whether he or she makes objections correctly.
- ◊ The plutonium facility at Los Alamos uses IV to teach workers the proper protocol for dangerous procedures.
- ◊ Among the many British companies who have produced IV to meet training needs are British Airways, British Steel and British Telecom.

Action 15

Managers
Develop procedures for obtaining and supervising the use of costly hardware and trained support staff.

Tutors
Become familiar with available packages in order to recommend appropriate purchases and to consider effective curricular applications.

Students
Take on more responsibility for learning.
Acquire new learning skills.

Issues

For the learner, IT systems at the implementation stage:

- ◊ permit greater flexibility in mode of delivery and teaching/learning strategies;
- ◊ help widen access to courses by supporting and enhancing open/distance learning schemes;
- ◊ increase the potential for individualisation of learning and for interactivity in the learning process;
- ◊ allow appreciation of misunderstandings and imperfectly understood concepts through the construction of an expert system knowledge base. (It is easy to reveal illogical thinking and inconsistent understanding when learners try to reformulate their knowledge as a series of interconnected rules and statements.)

For the tutor, IT systems:

- ◊ identify common errors and preferred learning strategies;
- ◊ increase understanding of the learning process through student work with tools like intelligent CAL packages and expert systems;
- ◊ facilitate assessment through computer-based record keeping (but note that assessment in personal development is not yet appropriate using computers);
- ◊ allow the close integration of the implementation stage of curriculum development with that of evaluation and review, by providing faster feedback and assisting in the collection and classification of this information;
- ◊ provide feedback to students quickly, letting tutors adjust course strategies and materials in the light of experience.

IT will play a major part in the delivery of The Open College curricula. Educational and training establishments hoping to support The Open College courses will therefore benefit from carrying out detailed investigations of how they may use IT for delivery in their own institutions.

Priorities

Again, some of the objectives outlined here are easier to achieve than others.

To take information networks first, electronic mail and local viewdata packages can be implemented at reasonable cost and without the need for lengthy training. On the other hand, computer and audio conferences require costly equipment and a lot of expertise in order to integrate them successfully into training.

At present, information centres are perhaps more relevant to the design stage of curriculum development than to implementation. This is largely because most institutions would find it prohibitively expensive to provide full learner access to online databases.

In the medium term, this will no doubt change – databases on **CD-ROM** [25] will become common and can be searched locally.

The ease with which CAL can be implemented depends on whether packages exist for a particular course, and on the supply and compatibility of computing resources within the institution.

If materials have to be written using an authoring language, there will be considerable delay before the course can be offered.

If an institution has to purchase hardware and arrange for its maintenance, the administration and staff training required will again delay the starting date.

Once the equipment is in place, management must demand adequate technical support to service it, and ensure that development teams have the time to install, update and (if need be) modify software.

In the case of expert systems, the key to the immediate future is the cost of available shells and the ease with which they can be used. At present, any plan to use expert systems with students requires heavy investment of staff time, as do other aspects of IT. This will slowly change as staff develop expertise and exchange information with colleagues. Already there are plans to set up regional groups to investigate and support the use of expert systems in the classrooms.

Any work staff can undertake in this area will be of value, since there has been little research into expert systems as teaching tools. However, it is important to recognise that they do not yet suit implementation in courses where there is detailed costing of the learning process and where trainers have to produce results fast.

Many institutions already use IT for information processing. Naturally, the extent of this use, and the specification of the hardware and software required, depend on particular courses.

The price of computers is falling, and technical support and staff training in the latest applications packages are likely to become the main problems for management.

Management should recognise that as IT systems reduce the need for staff/student contact and make didactic teaching styles less appropriate, tutors need more time to prepare new materials and to develop the necessary skills in order to use the technology to the full. Among those skills are the ability to assess software in context and a resource centre approach to accessioning, storing, indexing, loan and distribution.

One problem with the implementation of IT systems for student use is how to integrate the technology with existing teaching styles and course structures.

This problem becomes worse if there is far from enough hardware and software in the institution to offer the majority of students an opportunity of IT-aided learning.

Every institution must buy more computers, exploring the possibility of sponsorship from local industry and commerce if need be. However, there must be a continuing process of ensuring the most suitable organisation of resources within the institution. That includes setting up a programme to ensure compatibility and flexibility of access. Computing departments must not expect to have all systems under their day-to-day control, but on the other hand they may be responsible for setting up and observing an overall policy.

EVALUATION AND REVIEW

In the curriculum model we distinguish between two main types of **evaluation** [36]: monitoring (intended to collect data, appraise progress and quality, and detect and remedy problems without necessarily making radical changes in the course's framework), and review (which acts on the evaluation data, re-examines frameworks, considers alternative approaches, and reassesses the role of course in its wider setting).

Monitoring can provide two kinds of assessment – continuous (formative), and final (summative).

The process of monitoring a new course can lead to changes while it is still in progress. There needs to be continual reference to the criteria set down at the **needs analysis** [36] stage. Moreover, during **design** [77] and **implementation** [122], due consideration must be given to lines of communication that will allow reporting of and action on feedback.

The feedback obtained during evaluation should relate to the curriculum and to its organisation and management. There needs to be feedback at a number of levels – college, LEA, and central agencies. The simple matrix of Figure 5 shows this.

The evaluation component of the curriculum model must provide educators with the critical information needed to improve the course in question as well as all the steps of curriculum development. Thus no evaluation is truly worthwhile until the participants and providers have reviewed its results and taken any necessary action. The review process essentially concerns the management of this action.

People undertake the evaluation and review of curriculum provision for a number of reasons. On the one hand, tutors want to do their best for their learners and to provide training that meets both their needs and those of employers and other clients. On the other, educational institutions are professionally accountable for their financial administration.

Whatever the reason, you need to cost and review courses in accordance with sound basic principles. Clearly, the evaluation of outcomes can provide material for costing a course and for subsequent marketing.

Proper evaluation and review require considerable time and effort. It is therefore important to manage this stage of curriculum development efficiently.

Several IT systems described in this document may support the process.

	Tutors	Managers	Learners	LEA	Employer
Planning and organisation					
Nature of curriculum					
Guidance, counselling, assessment					
Achievement and accreditation					
Resource expenditure					
Costs involved					

Figure 5

Information networks

Information networks [17,32,103] produce greatest benefit when you need to obtain evaluative comments and reviews at different levels. Staff can contribute quickly, and feedback will therefore be more effective.

If more than one college is handling a programme, **electronic mail** [20,123] can encourage and facilitate inter-college course operation and monitoring.

At the review stage, trainers often have to liaise with a range of external agencies or sponsors, as well as with finance officers, support staff and other colleagues. Electronic mail can reduce delays when communicating information or arranging meetings.

In this project, FEU will evaluate the use of electronic networks itself, to show level of activity and how the networks can aid curriculum development.

The Open University's experience of **audio conferences** [23,125] and of telephone tutorials with individuals or small groups has shown that these techniques can help several aspects of evaluation.

For instance, telephone tutorials clarify student difficulties with materials, and promote student discussion of specific issues and topics. This would be a costly method of obtaining student feedback were students in one location, but we can justify it if they are geographically dispersed and taking part in a distance learning scheme.

Colleges should not shrink from external review of their training; then they may use audio and **computer conferences** [19,128,199] to exchange information with institutions and central bodies.

In Phase 2 of this project, the central body concerned will be the FEU.

Action 16

Managers, tutors, students, LEA advisers, and employers
Use information networks to exchange information in both monitoring and review.
Use electronic mail to assist with the organisation of meetings and audio and computer conferences.

Tutors
Use electronic networks to co-operate with colleagues teaching the same (or similar) courses in other colleges, to help consolidate the evaluation work of each.

Information centres

As more information pertinent to evaluation and review arrives, it needs to be collected and collated. At regional and national levels, this involves storing the information in a powerful database as part of an **information centre** [entry]. You will have to set up mechanisms to collect information concerning resources, staff development costs, organisation, and so on, held on databases at individual institutions.

The resulting regional and national information centre databases should greatly assist the allocation of annual budgets at LEA and government levels, as well as the costing of new initiatives.

Action 17

Managers of educational and training establishments
and
Evaluators
Initiate discussions at local level to determine a common structure and a standard for databases that will contain information about evaluation and review at each establishment; later regional analysis will be easier as a result.

Managers of institutions
Maintain a database of staff development in new technologies and training techniques, including associated costs.
Ensure that evaluators also keep database records.

Computer-assisted learning

With the trend towards modularisation and the introduction of more open learning schemes, a growing number of staff will need to be familiar with the techniques of evaluation and review. **CAL** [entry] packages can partly disseminate this expertise.

Staff training material should recognise that normative evaluation on its own is not enough for courses that make innovative use of IT systems as a teaching/learning strategy.

Computer-assisted learning and **interactive video** [entry], for instance, provide not only different ways of learning things, but also ways of learning different things. The systems may cause the aims and objectives of a course to change, and it is hard to devise pre- and post-tests to compare old and new methods when the objectives of the training are no longer the same.

Related to the storage of data as information could be the use of **expert systems** [entry] to organise and present that information, and to help the various techniques of evaluation and review.

Two assessment procedures that lend themselves to an expert system application are mentorship (the involvement of an experienced colleague in helping to present evidence), and triangulation (the involvement of a third party in the process of verifying evidence to obtain opinions from a different perspective).

In theory, but not with real success in practice so far, expert systems can also provide intelligent interfaces with complex packages. This makes the packages easier to cope with. It may be possible to apply expert systems in this way to sophisticated programs intended for use by course evaluators.

Action 18

Evaluators
Investigate the possibility of collaborating in the writing of either a CAL package or an expert system, to assist with the procedures of evaluation and review.

Computer-managed learning packages [entry] help trainers collect information that should be of use at the evaluation stage. However, while they facilitate quantitative evaluation, for instance by storing details of student achievement, they do not facilitate qualitative information. This is because they exclude crucial factors of student experience and fulfilment. This latter kind of information is hard to collate and evaluate, but you should not ignore it, since it relates directly to the learner's values and needs. Interactive questionnaires can be of great value here.

Information processing

Information processing [entry] systems can be used to analyse (as with **statistical packages** [entry]) and present (as with **word processors** [entry]) the results of an evaluation. **desktop publishing** [entry] would enhance the communication of the findings.

Information processing systems are of special use in external reviews when summary information reports have to be produced in different forms for different reviewing bodies.

Action 19

Evaluators
Create a database of the results of evaluation exercises, questionnaires, and so on, completed by learners and employers.
Where appropriate, negotiate with other institutions to ensure compatibility of databases containing similar data.
Use desktop publishing or sophisticated word processing packages to produce reports in different formats for different audiences.

Tutors
Ensure you update files of course materials in the light of the evaluation.

Managers of education and training establishments
Initiate the use of desktop publishing systems to produce certification on demand, to reduce printing costs in situations where courses are on offer at short notice.

Image processing

Video [49] is a well-known method of evaluating both student and tutor performance. Equally, since it is a familiar medium, there are tested criteria for evaluating its use in courses.

Interactive video [49 109], on the other hand, is comparatively new, and designers are only just reaching a consensus as to what constitutes good practice.

Facsimile [46 110 191] machines are an efficient means of circulating diagrams, graphs, or visual materials to external evaluators. This is especially so if evaluative comments about a course are needed from employers. Local firms are likely to have fax machines and to be familiar with their use. As a result, questionnaires sent this way are effective in obtaining feedback from employers who might not have time to fill in and return a conventional form. Fax can also help ensure security in the communication of confidential material – the timescale for dissemination by fax is no longer than a day.

Action 20

Evaluators of courses implementing IV
Draw up draft guide lines for the evaluation of IV.
Exchange opinions with colleagues so you can adopt working guidelines.

Tutors
Use fax to obtain feedback from employers and to transfer marked schedules and copies of confidential reports.

Issues

Staff may have had experience of different aspects of curriculum development – experimenting with new teaching methods, for instance, or updating materials. Rarely have they had the chance to consider the curriculum as a whole, and to assist with the development of a new course from conception to evaluation and review. IT in support of curriculum development can provide that opportunity.

In addition, IT systems facilitate communication and processing of information, and thus shorten some phases of curriculum development. It also seems likely that the various curriculum development processes will become more integrated. It should, for instance, be easier to relate the evaluation of a course to the initial analysis of needs, and to modify a course in the light of a review.

As a result, the maintenance of training will become a structured affair; both students and employers will benefit from the greater relevance of educational provision.

Because IT provides the means of obtaining feedback at all stages of the development cycle, a wider range of opinions can be taken into account. It is now easier to share stimulating and original developments, hitherto implemented by tutors in isolation, during the monitoring process, and later to incorporate them into curricula.

One issue that will require careful consideration is the use made of fast evaluation and review, not only by institutions, but by central bodies.

Priorities

In the short term, any programs that evaluators use to automate the process of evaluation may impose an increased burden on them. Internal evaluation, for instance, often requires considerable tact and sensitivity when you deal with colleagues.

It is possible to reduce some aspects of an evaluator's task to mere procedure – but not all of them. Evaluators will therefore need to analyse their job with care, to identify those tasks where they can work with IT effectively.

Inevitably, once IT is used in the context of evaluation, there will be a period of staff development before returns on investment can be fully realised.

Information processing tools are immediately available to help with evaluation; it is a good thing to concentrate on encouraging the use of these systems in the first instance.

Other applications identified here require the writing of software. Evaluators will need time and resources in order to develop the programs, and if an institution is not able to produce them in-house (or by initiating local collaborative projects), there will be further delays until the software is available. In the meantime, it is important to raise staff awareness of the potential of IT in their particular fields.

SUPPORT

The FEU curriculum development model includes **support** [11] at its centre in order to confirm that each stage in the process may need it. Support may come from management, groups within the college or training establishment, or from external agencies (including FEU).

In the FEU model we include in support at least four areas:

- ◊ to provide research information;
- ◊ to implement and to maintain information and dissemination systems;
- ◊ to ensure staff development provision;
- ◊ to provide general resources: facilities, support staff, finance.

An information technology support system of the kind we outline in this document would not supplant traditional facilities. People are the main resource for curriculum development and will remain so if you introduce an IT support system.

Rather, we envisage that the use of IT in curriculum development would increase the flexibility of educational provision, and encourage relevant, learner-centred curricula.

An information technology support system will itself require maintenance and adequate resources. During this project, FEU (with MSC funding) will supply support to the various people involved in participating institutions.

We identify four groups:

- ◊ managers of the college or training department;
- ◊ staff responsible for introducing new methods;
- ◊ staff involved in using new educational/training techniques;
- ◊ support staff within the institution.

Such a broad categorisation as this is of general use in considering the implementation of new methods. In Phase 2 of the project, we shall place emphasis on the staff responsible for the introduction of these methods.

IT will have a function in the maintenance of an IT support system. Clearly the provision of adequate support at technician level will be a vital factor in the success of any attempt to apply IT to curriculum development work.

Information networks

As the use of IT for curriculum development spreads, so LEAs and individual institutions will need to develop policies for staff development in both technical expertise and new teaching strategies. Identified demands must be the basis for these policies.

You can use **information networks** [10, 64] first to elicit information from a range of people concerning staff needs, and secondly to disseminate staff development materials quickly and efficiently.

Staff will be able to study at a time convenient to themselves, and although they will need some face-to-face INSET, the number of costly courses they have to attend will fall.

Action 21

Managers and those in charge of staff development
Use electronic networks to help identify staff training needs and to devise courses for staff that networks can partly implement.

LEA advisers
and
Officers of central agencies responsible for curriculum development
Use electronic networks to exchange information about staff development programmes in order to eliminate duplication of effort.

Information centres

Information centres [IC 1988] will become increasingly important to educational establishments as central agencies build up their databases of vital information. Access to these large databases will, therefore, be a key issue.

The role of librarians and of other college staff with experience of information retrieval will be greater than before. Managers should ensure that these staff are up to date with new developments, and that their standing within and support from the institution reflect their increased responsibilities.

LEAs and central agencies will need to ascertain the changing needs of colleges following the implementation of an IT support system.

For instance, it may be appropriate to initiate regional databases of information that would be of use to a number of colleges. A database of consultants with their mailbox numbers could become a important resource for staff, especially those directly engaged in curriculum development work.

In Phase 2 of this project, FEU will maintain a database of pilot projects set up in colleges (including contact information), so that people can obtain details of work in progress.

Action 22

Managers of educational and training establishments
Ensure you have staff trained in information retrieval methods, and that the terms of their contracts and their working conditions reflect the growing importance of their role.

LEA advisers
and
Officers of central agencies
Undertake a survey of the kinds of information colleges and training departments would wish to see stored in information centres for their use.

Computer-assisted learning

We have already suggested that **CAL** [CAL 1989] packages of staff development materials could be an important resource. Staff development in new technologies is crucial, and yet institutions can rarely afford all the retraining their staff need. CAL programs developed centrally and disseminated cheaply throughout the system would ease the problem, as long as enough hardware was to hand.

Some courseware for staff development has been developed as a result of Education Support Grant (ESG) funding and MSC Central Reserve Funding for work-related non-advanced further education in order to promote the use of IT in this sector. We hope these materials will be subjected to peer review, and, where appropriate, made available nationally.

Regional development centres in receipt of ESG funding for staff development in IT should identify areas where there is still a need for courseware for staff development, and publicise this information. It is part of their role to fill identified gaps of this nature.

Action 23

FEU
Make the database of ESG courseware projects available in a variety of formats, so staff trainers can identify promising staff development material, and ascertain those areas where there is a need for more.

Managers and others buying training materials
Commission training needs analysis packages where none suitable exist (there are currently some paper-based systems that allow an evaluation of the needs of an organisation, and which provide a cost-benefit analysis of training).

Tutors
Search FEU's *Directory of courseware* for published staff development materials in your subject areas.

Information processing

Within the support process, **information processing** [39 173] has much to offer staff development. For instance, **relational databases** [39 184], **word processors** [39 173] and **spreadsheets** [39 187 208] are of value within an establishment to maintain records of staff development needs and to cost various staff development programmes.

Desktop publishing [42 172 208] can produce staff development materials to a high standard of presentation for dissemination on a regional or national basis at fairly low cost.

Action 24

Managers of educational and training establishments
Use information processing tools to record the training needs of staff, and to cost alternative staff development programmes.

Tutors with responsibility for staff development
Explore the possibility of using desktop publishing to publish staff development materials.

Resource managers
Use relational databases to record the use of the IT support system, details of software packages recommended for purchase, and accommodation needs.

Image processing

Within the field of **image processing** [47 186], **facsimile** (fax) [39 174] will promote closer links between educational establishments and industry/commerce (who make extensive use of the technology already). Firms may think it worthwhile to sponsor fax within colleges, and to provide advice on it when asked.

Action 25

Managers of educational establishments
Initiate discussions with local firms to obtain assistance with the installation and use of fax.

Issues

Many issues relate to the maintenance and resourcing of an IT support system. They include:

- the extent of staff training needs in the use of various systems;
- the resources required by institutions;
- the role of support staff;
- costs.

Staff development

Most people recognise that staff development programmes are more effective when student needs closely influence the organisation of the institution as a whole. This is because such institutions will already be used to inter-departmental collaboration and flexible working patterns.

An IT support system will encourage management and staff to adopt flexible and supportive working procedures, since all types of IT promote communication and the rapid dissemination of information.

Thus, although an IT support system will entail a considerable staff development programme, it will also promote conditions for the success of that programme.

Nevertheless, LEAs and central agencies may have to provide help with staff development.

The general objectives for staff development in relation to the adoption of the various IT systems need realistic definitions for different groups of staff. It is not likely, for instance, that most tutors will ever become as knowledgeable and enthusiastic about the use of technology as those responsible for promoting IT within an institution. This is why, if a training programme is to use new methods and materials, in the early stages of its development it should involve those who will eventually deliver the course.

Resources

There is a paramount need for institutions to obtain up-to-date and unbiased information about available systems (both hardware and software).

Besides the FEU, the Council for Education Technology (CET) provides advice about IT. Other sources of information and independent advice need identification and good publicity.

However, information about the technology available is of little use to those without money to pay for it.

The integration of self-paced learning and traditional teaching methods is a major problem in institutions where there are insufficient computer keyboards. Colleges should explore the possibility of industrial/commercial sponsorship, and apply for central or local funding to support IT-related initiatives wherever this may exist.

Support staff

LEAs, colleges and training departments will need to develop new policies for support staff based on the demands of implementing and maintaining an IT support system. These staff will become essential members of a teaching team, and will have far more contact with students. They too will require training programmes, and wherever appropriate should access INSET activities jointly with tutors.

Management issues

In a period of strict budgetary limitation, any innovation must be cost-effective as well as an improvement on former practice.

In the long term, an IT support system should enable institutions to enhance their provision, improve their flexibility, and shorten time scales when designing new courses. As a result, institutions should be able to deal with a greater number and range of learners at little extra cost, and so increase their income.

In the short term, institutions will need to invest in costly equipment, in staff development, and in extra support staff. It is therefore imperative that you carry out detailed unit costings to ensure you spend funds wisely at every stage of this initiative.

The compatibility of hardware and software within a college is an important issue and will allow some standardisation of approach. We can use the matrix of Figure 3 to plan the framework of a college-wide IT policy. For instance, it may become clear that a database program required for needs analysis and course design can be used at the implementation stage with students as well. From the start, equipment and software should be bought with such considerations in mind. The matrix can therefore not only suggest applications for IT that require funding, but also indicate how to spend funds to maximum benefit.

In Phase 2 of the project, when FEU tests aspects of the IT Support System in colleges, we hope to obtain detailed costings to assist institutions wishing to adopt some of the suggestions in this document.

You may also like to consult the final report of the MSC's *Joint Efficiency Study*.

Information technology is a rapidly changing field; its applications in education and training are hardly less so.

Managers must remain informed of the latest developments, so they can make the right decisions when implementing IT in their institutions. They can do this by appointing a suitable person or group with overall responsibility for IT, and ensuring they set up mechanisms whereby regular discussions can take place and lead to feedback and dissemination.

Managers need up-to-date information about the applications of IT to every stage of curriculum development. They must know of existing information centres that contain details of education and training provision, for instance, and use these where appropriate in the analysis of values and needs. They should also be aware of the potential of online databases and electronic networks in both the design and the marketing of courses.

In some cases, managers can actually use IT to raise their awareness of new developments. For instance, the Open University multi-media pack *An introduction to computer-based training* offers guidance on where and how best to implement CBT (CAL). **Computer conferencing** [19,26] and **TTNS** [20] give access to a range of opinion about relevant topics, such as the role of computers in education.

Managers ought also to be able to work with the new technology – or at least ensure that staff who should be using IT have proper training and adequate equipment.

We all need to recognise that, though the financial resources needed to support the use of IT systems may be greater or less than those required with conventional methods, they will certainly be distributed differently. For instance, you are likely to need:

- ◊ more facilities in resource centres and libraries, including materials, equipment and individual learning spaces;
- ◊ larger budgets for the purchase of existing course materials;
- ◊ better contacts with other educational and training establishments, to facilitate exchange of information and materials;
- ◊ better credit transfer arrangements for students, especially for those working in a distance learning mode (where a different fee paying structure may also be appropriate);
- ◊ more support staff, such as production teams for teaching materials, administration teams to run resource centres and to supervise the delivery of distance learning; technical staff will be at a premium.

As a result, budget patterns to support the use of IT systems will look rather different from those required before. There will be high initial capital costs (for equipment and for purchase or production of materials), a higher administrative budget, but, perhaps, lower routine expenditure.

Finally, there must be a widespread change of attitude among staff as IT is introduced into the curriculum development processes.

For instance, courses and course materials will become much more public, and there will be a pressing need to acquire and share information about training activities – not only within, but also between, educational and training establishments.

Management will need to be alert to potential problems in order to ensure that the transition to IT-based methods is smooth.

Almost certainly the best way to do this is to identify a competent senior staff member with full-time responsibility for ensuring co-ordination of all the institution's work in these areas. The co-ordinator need not be an expert in IT (business studies, resources and library work are just as relevant specialisms), but must be enthusiastic and popular. It is essential that all staff refer to the co-ordinator before moving in any of the directions suggested in this report, and that they keep him/her informed.

PHASE 2 OF THE PROJECT

There are three dimensions to the specification of work in Phase 2 of the project:

- ◊ the specification of work in colleges;
- ◊ the relationship of work in the colleges to the overall aims of the project;
- ◊ the degree to which the proposals combine the various areas in the matrix (figure 3) in one college project.

The specification of work in colleges should take account of:

- ◊ aims;
- ◊ relationship to the overall model of interaction between the curriculum development processes and IT;
- ◊ method of implementing the college work;
- ◊ support from FEU;
- ◊ support supplied by the college and LEA;
- ◊ outcomes.

As regards how work in each college relates to the overall aims of the project, we shall check that there is a spread of activity, and that projects in different institutions interact.

The degree to which the proposals combine the various areas in the matrix of figure 3 in a given college project is important too.

For instance, in the design of a curriculum, you can use both networking for consultation and databases to access existing data; alternatively, the design of a local course could involve the use of information processing in several stages of curriculum development.

To allow the involvement of all participating institutions in dissemination, and to let us cover as many possible elements of IT, each will receive the hardware it needs for its project(s). FEU will make every effort to ensure compatibility.

We shall monitor the college projects to assess the impact the use of IT has on the FEU curriculum development model.

To help the monitoring process, FEU has set up a framework designed to highlight the benefits of applying IT to the various curriculum processes. The framework comprises various benefits; we include in the list that follows the codes we use:

- ◊ improved curriculum quality (ICQ);
- ◊ error reduction (ER);
- ◊ increased flexibility (IF);
- ◊ increased speed (IS);
- ◊ increased management capability (MC);
- ◊ cost reduction (CR).

We base this approach on a method of assessing the benefits of a software system. It is obviously harder to collect and measure the less tangible effects that relate to curriculum quality, such as the attitudes of staff and students to the introduction of IT.

Direct benefits may appear in such task areas as:

- ◊ calculating and printing
- ◊ record keeping and searching
- ◊ analysis and simulation
- ◊ process and resource control

Here are some examples relating to the project in each of these areas.

Calculating and printing

- ◊ improved quality of presentation (ICQ)
- ◊ improved accuracy in the tasks (ER)
- ◊ ability to change values (IF)
- ◊ increased speed in calculating and printing (IS)
- ◊ reduction in the costs of calculating and printing (CR)

IT systems concerned include DTP, word processing, spreadsheets.

Record keeping and searching

- ◊ automatic collection and storage of data for records (CR IS ER)
- ◊ improved security (ER CR MC)
- ◊ improved ability to change records in databases (IF CR IS)
- ◊ increased curriculum quality (e.g. at the stages of needs analysis and evaluation and review) (ICQ)

IT systems concerned include relational databases, computer-managed learning systems, online databases, electronic networks.

Analysis and simulation capability

- ◊ ability to perform complex simultaneous calculations quickly (IS IF ER)
- ◊ ability to create simulation of complex phenomena (e.g. in order to ask 'what if' questions) (MC IF)
- ◊ increased curriculum quality (e.g. at implementation)

IT systems concerned include CBL, expert systems, spreadsheets.

Process and resource control

- ◊ increased flexibility in teaching methods (IF)
- ◊ improved ability to 'fine-tune' instructional or teaching processes (RC MC IS ER)
- ◊ increased curriculum quality at the design and implementation stages (ICQ)

IT systems concerned include CBL, electronic blackboard, databases of teaching materials.

The indirect effects we shall take into account when evaluating the impact of IT systems on curriculum development will include:

- ◊ teacher attitude to the integration of IT into the curriculum development processes;
- ◊ student attitude to the use of IT in the implementation of the curriculum;
- ◊ the teacher's previous experience of IT;
- ◊ teacher perception of creativity in relation to the use of IT systems;
- ◊ the impact of the use of IT on the institution;
- ◊ the extent to which the use of IT is likely to become embedded in the institution.

A simple matrix – Figure 6 – can show how IT systems used to assist with the task areas listed in Section 2.10 can produce tangible benefits. We can also use this matrix to show some indirect effects of using IT. We shall record these in the elements relating to curriculum quality. FEU proposes to use a matrix such as this to help monitor the use of IT in the college projects.

Benefits / Curriculum processes	Curriculum quality	Flexibility	Speed	Reduction in error	Management capability	Cost
Values and needs						
Design		Each area of the matrix should refer to the task or operation shown in list		Calculating and printing tasks Record keeping tasks Record searching tasks		
Implementation				Restructuring capability Analysis and simulation capability Process and resource control		
Evaluation and review						
Support						

Figure 6: Possible benefits of using IT systems in curriculum development

In addition, FEU has drawn up a form for the project team to collect monitoring information during their regular visits to the college projects. We shall record, for instance:

- the curricular areas in which the college is working;
- the IT systems in use;
- the tasks involved;
- a description of how these tasks were previously completed;
- an account of the perceived improvements of applying IT.

At the same time, the project team will record details of the actual process of applying IT in areas of curriculum development. That is, they will note problems encountered by the college projects and record aspects of good practice.

The findings of Phase 2 are the subject of a final report. This systematic monitoring procedure will help to clarify details of the use of IT that have so far been the subject of anecdotal evaluation only. We hope to show whether the introduction of IT systems is likely to produce superior results in terms of, for example, cost, flexibility, accuracy. FEU envisages that the monitoring framework established in this project will be transferable to other related IT projects.

APPENDIX A

COMPUTER-ASSISTED LEARNING

Why use CAL?

A1 The term computer-assisted learning (CAL) covers a wide range of packages; they offer a variety of learning modes. CAL can:

- ◊ influence the ways tutors teach a subject;
- ◊ influence the ways students learn a topic or skill;
- ◊ open whole new approaches to some areas;
- ◊ act as a catalyst for curriculum development.

A2 CAL has many advantages:

- ◊ it is infinitely patient;
- ◊ it provides instant feedback;
- ◊ it is interactive;
- ◊ it constitutes an alternative resource as an aid to understanding;
- ◊ it offers an alternative teaching strategy;
- ◊ it can reduce the time taken to learn a topic.

A3 CAL has some disadvantages:

- ◊ it is impersonal;
- ◊ it is poor at instruction compared to most tutors;
- ◊ it can be slow to cope with student errors.

Potential

A4 Despite the disadvantages, CAL has vast potential in education and training, and as we better monitor and evaluate its effects, so we shall be able to put it to more judicious use.

We can advance no single case for CAL, any more than we can for lectures or small group work. In the right contexts, people learn effectively from good CAL materials, and more or less ineffectively from poor ones.

Some people have expressed reservations that technology-supported learning may impoverish the learning experience, and that we should not lightly abandon face-to-face teaching in the name of efficiency. However, we must remember that we can offer CAL packages for individual or group work, or integrate them with traditional teaching modes. Moreover, there are situations in which the shortened learning times claimed for CAL methods are crucial – as in the case of retraining or updating programmes for people in employment, for instance, or when students have to catch up work missed through illness.

A5 CAL packages are more readily available than some of the IT applications discussed in this document. Also their quality and use have been assessed to a greater extent – though many would still claim not extensively enough.

Some of the most successful experience of using CAL has been in industry (where they often call it computer-based training, CBT). HE can learn much from this experience, though there are differences: trainers have more money with which to experiment than tutors in education; their objectives tend to be easier to define and less ambitious; and their curricula are much shorter and more specific.

A6 The length of HE courses makes it hard to introduce packaged learning of any sort as a substantial element of the curriculum. Also you must package a substantial fraction of the content of a course before it is worth the effort of changing established patterns of timetabling, introducing students to new learning modes, and providing needed equipment.

A7 At present it is not at all clear that, in education at least, CAL is more cost-effective than traditional methods. This is because the criteria of comparison still await full definition. For sure, the production of CAL materials requires an expert team, and is also costly in terms of resources and staff time.

We can justify such investment of time, resources and expertise only if the resulting package is for wide use – and the shortage of equipment in many institutions still prevents this. Moreover, CAL materials date like any others, so we need extra resources to update, modify or replace them.

A8 The shortage of good quality software is yet another barrier to the wider use of CAL in education. Tutors will not (and should not) use IT for its own sake, but only if convinced it has real benefits.

In further and higher education, however, several factors mean that colleges will need to adopt strategies to make their courses more accessible in the learning market of the 1990s. These factors include:

- ◊ the advent of The Open College;
- ◊ the general blurring of distinctions between education and training;
- ◊ the increasingly easy access to learning outside the established patterns of long courses at single institutions.

In this context, CAL and other forms of IT-based learning have an important role.

A9 Simulation and modelling CAL packages are likely to grow in importance. There is much appreciation of the benefits of simulation as an approach to learning even without use of a computer. The advantage of basing simulations on a micro is that the hardware provides a powerful and flexible way of controlling them.

The learner is usually responsible for providing input into the program, having decided on some strategy of use, and can experiment with the model. The learner therefore gains insight into the process or system concerned.

A computer model may be the only way to provide a safe, cheap and speedy view of certain phenomena (such as shop management, nuclear reactions, robot control, and the working of the human body). In training, simulations are of value when the real task is hazardous, costly, inaccessible or unavailable for training purposes. Simulations are often cheaper than the real task – as is the case with pilot training – and they can be of use in assessing skill level before transfer to the job.

The limitation of simulations is that by definition it is not easy to include much of the real stress associated with the actual task situation. It is also sometimes hard to design the type of simulation that will be most effective.

APPENDIX B

DESKTOP PUBLISHING

What is dtp?

B1 Desktop publishing (dtp) is the production of documents using a small ('desktop') computer and a high quality (page or good dot matrix) printer. We call that combination of hardware a desktop publishing, or computer-aided publishing system.

Such a package can print various kinds of graphics (for instance charts, graphs, halftone photographs and line art) on the same page as a variety of styles, sizes and layouts of text. Lines, boxes, shading and, in some cases, colour can be incorporated.

B2 Although the quality of the output from current printers is not as high as that from conventional typesetting, it is often good enough for the majority of applications in education – for instance, worksheets, circulars, posters, prospectuses, exam papers and magazines.

The printed output can be distributed as it is or photocopied, or it can be used as camera-ready copy for an offset printer. For full typeset quality, the dtp hardware can be linked to a photosetter instead of to a printer.

Why use dtp?

B3 There are various advantages of dtp:

- ◊ cutting the cost of new or revised publications;
- ◊ cutting the origination period of new or revised publications;
- ◊ cutting the time spent by managers on supervising and chasing each stage of document production;
- ◊ creating a better image in the case of material aimed at the public;
- ◊ increasing the range of work you can undertake yourself;
- ◊ making it easier to re-use material for a variety of purposes (including creating searchable, selective electronic versions of catalogues of teaching materials for instance).

B4 The main disadvantages of dtp are that:

- ◊ its adoption almost always leads to changes in the roles of the people involved in producing printed teaching material – changes which may not work where demarcation is an issue;
- ◊ in the absence of any support, those dtp users who are not designers are likely to tackle work beyond their capabilities.

Many newcomers to dtp lack any formal training in graphic design. This may not matter, if they limit their work to simple material. Complex documents need much more care in the presentation of information, and most documents for learners – especially for self-study – are in this category.

B5 The decision to introduce dtp must therefore be taken with care. If user to prepare short-life worksheets, for example, that otherwise would have been typed or produced on a low-cost printer and photocopied, the result is sure to be an improvement – but it will not be cheap.

On the other hand, if dtp is used to prepare student booklets and other long-term material that would otherwise have been professionally produced, the results may be cheaper but they probably will not be acceptable unless staff have been trained in layout and graphic design.

B6 Use Dtp, initially at least, to enhance the presentation of learning materials at reasonable cost, rather than to make financial savings at the expense of impairing students' overall learning experience.

Choice

B7 There is a wide variation in the cost and sophistication of the hardware and software of desktop publishing. The capital costs range from a couple of thousands pounds up to £100,000 and more, even with discount. However, prices and features change very quickly.

The two main weak links in the cheaper dtp systems are the screen and the printer. In fact, the printer is probably the most important part of a desktop publishing system. Its output quality will determine how good your final pages look.

B8 Common problems with cheaper dtp systems may be:

- ◊ the printed output is of noticeably lower quality than that of a photosetter;
- ◊ the printed output does not include graphics;
- ◊ what appears on screen does not closely resemble what appears on the printed page (and is of poorer quality) – this because the screen cannot show such fine detail (it has a lower resolution than the printer);
- ◊ there is a greater need for users to intervene at each stage of document production (for instance, to draw artwork by hand and to paste it into the final page if the system cannot print it).

B9 The choice of dtp system should be governed, in part, by the likelihood of using material from outside sources or sharing or selling material. In order to avoid re-keying text, collaborating institutions should store information in a similar fashion in their dtp systems.

B10 Desktop publishing systems up to £3000 (1987) typically comprise a low-cost micro, a simple word processor, and a printer with a resolution of 200–300 dots per inch (dpi) and 4 pages per minute. Most of these can be used only as stand-alones rather than on a network (when there could be co-operative authoring and sharing of costly hardware).

These systems may not be able to cope with anything but a single size of text, a single typeface, and very simple graphics – such as horizontal and vertical lines; the word processor program may not be able to create or edit pages containing graphics or a mixture of typefaces – even if it can do that, the micro may not be able to display the result on the screen and/or the printer may not be able to print it.

B11 Any system in the £3000 – £10,000 price range (1987) should be able to display and print halftone graphics and a range of typefaces, as well as having programs for each stage of interactive page layout. These last include sizing up, juxtaposing, and precisely aligning text and graphics prior to printing. Users of systems based on the Apple Macintosh have a wide choice of programs for each stage of document creation – from drafting and editing text or graphics, to laying out pages on the screen.

Users of IBM systems have a wider range of outliners and word processing programs than those of the Macintosh; however, often these programs offer fewer facilities. For the IBMs there is also less choice of software for creating high quality artwork, and for creating page layouts.

B12 Systems costing £10,000 upwards (1987) are, in general, for use by a group of people with a variety of computers. Cheap micros, like the Apple Macintosh or IBM PC, can help with the first drafts of text. You then use powerful desktop workstation computers for later drafts and for graphics creation. The workstations have more computer memory and processing power, as well as larger screens (sometimes capable of displaying two A4 pages at once).

B13 All computers in such systems would have shared access, via a network, to central resources such as printer and optical **scanner** [42]. (This last device reads an image — photograph, line art, or logo — as well as straight text, and turns it into a file which a page make-up program can crop and fit into the final document for printing.)

The output from a workstation may go to a photosetter or to a high-performance page printer. Page printers in such systems work faster than those mentioned before. That is, they may produce as many as 100 A4 pages (or 20 or more A3 pages) per minute — compared to the ten or so A4 sheets per minute of the cheaper systems. They may also have refinements such as spot colour (printing some parts of a page in a second colour), double-sided printing, and a quality of output that approaches photosetter standard.

Graphics

B14 There is wide misunderstanding about using computers for producing print graphics. At present, dtp systems able to output really high quality work are too costly for most educational and training establishments; anyway they offer no real advantage over conventional cut-and-paste use of line artwork and ordinary halftones.

It is easy to envisage a graphic image — of a photograph, line drawing or halftone artwork — held as a file in an electronic store. However, in practice this needs a huge amount of computer storage space, especially in the case of a photograph or video frame. A picture reproducing at 300 dots per inch (the dtp standard but too coarse for serious work) may take up a whole floppy disk. At the moment, therefore, for a really professional finish, it is quicker and cheaper to prepare such material in the conventional way, leave spaces in the pages, and let the printshop finish the job by marrying the two.

Similarly, though you can produce line art work with a painting or design program, such programs may be built to work only with the coarse 72 dots per inch output of a cheap matrix printer. This means that the image breaks up when put through a better machine.

B15 Dtp systems, however, offer a real advantage when it comes to charts, simple logos, and ruling for elaborate page make-up. Here the results can be effective, and the use of computers saves a lot of time.

APPENDIX C

EXPERT SYSTEMS

What are expert systems?

C1 People in the commercial and industrial sectors expect the use of machine (artificial) intelligence to increase significantly in the next ten years. The growth will include the application of expert systems.

C2 The appeal of expert systems is their ability to absorb, store, organise, manage and retrieve human knowledge in a way that lets non-experts access and retain the facts. Thus the knowledge can become more widely available.

Expert systems are still the subject of much research and development; however, even in their present form, they can guide the user to possible solutions to a problem, often with percentage weightings. An expert system can also provide reasons for its conclusions.

Manufacturing applications include quality control and industrial process planning and estimating.

C3 In essence a knowledge-based expert system consists of the following:

(a) classification of the facts and concepts concerned and the relationships between them – the knowledge base.

(b) procedures (rules or heuristics) for manipulating facts – the inference engine (processor).

(c) information about when and how to apply the rules – control.

C4 The control section (or user interface) is a program that lets users engage in a dialogue with the inference engine. This may be by typing answers to the questions displayed on screen. The system will then supply new information or modify its knowledge base as required.

Most current interfaces are not friendly to people unused to programming. Thus the input part of the interface cannot understand ordinary English – it is restricted to a small vocabulary and special syntax, or expects the operator to select from screen menus.

C5 In the same way, the output part of the interface (which provides messages to the user) is generally unsatisfactory for a beginner. Its questions, its conclusions and its explanations do not often vary to take account of earlier parts of the dialogue – in other words, they are insensitive to context, relatively stilted, ordered in an unnatural way, and couched in terms few can understand.

C6 An expert system knowledge base contains information about a single field. However, the rules for drawing inferences and the control procedures for applying those rules are relevant across a range of knowledge bases.

Shells

C7 Shells comprise only the rules for inference and control, and have no knowledge base. A variety of general purpose expert system shells can be bought 'off the shelf' – content-free packages that let you develop expert systems without programming knowledge.

A knowledge engineer, in collaboration with an expert in a given subject area, can fill these shells with knowledge – and so can the learners.

An adviser is a shell fitted with a body of knowledge.

C8 Early shells were very complex, and required information in a special order (from the more general to the specific). Modern shells have their own sets of rules; these assist in the knowledge acquisition process and help with the organisation and structuring of specialist knowledge so the system can more easily handle it.

C9 The arguments for and against using a shell are similar to those regarding the use of authoring systems for producing CAL software.

Shells are convenient for people who are not programmers; they are also adequate in many cases (for instance, where the need is to produce a prototype expert system quickly).

In other cases, the limitations of shells make them less appropriate. Chief among those limitations is the likelihood that a shell cannot properly meet the needs of a problem. Maybe the problem differs in some important way from that in the minds of the designers of the inference engine and user interface.

C10 For instance, a shell may allow only one way of representing knowledge, one way of making inferences, and one kind of user interface.

Consider the effect of limiting knowledge to just one representation. If there is a problem such as machine fault diagnosis, there might in practice be a need to use one kind of representation for knowledge about concepts, another for that of routine checks, a third for heuristics, and yet another for classifying faults.

Potential

C11 Clearly an expert system is best suited to those areas of knowledge (domains) which have strict boundaries and in which the facts are rarely a matter of debate. For this reason, until more sophisticated expert systems appear, the potential for education is not great.

Nevertheless, many subject experts are enthusiastic about what expert systems can offer in their fields. Some have written applications for students of law and medicine for instance.

C12 Few organisations have the resources to develop the advanced uses of expert systems to repace tutors, even if they thought such applications desirable; in any case, no system so far can perform at the level of a capable human tutor.

All the same, the technology of expert systems can be readily and valuably applied to small-scale specialised applications within curricula, if prospective users receive appropriate support.

C13 For sure, expert systems will be more important in education in the future, when they are easier to use and more readily available. Techniques developed by knowledge engineers promise improved understanding of (among other things):

- the effect of learners' prior knowledge and expectations on their interpretation of advice and information;
- how learners acquire, classify, integrate, and make use of new knowledge (for instance, concepts or steps to accomplish a task);
- the effect on learning of the method of presentation.

You can also use an expert system to build up a knowledge base of how learners react to different teaching methods. It might include strategies and patterns of student errors, and also details of how a student's existing knowledge and attitudes to study affect learning.

Resources

C14 Two types of resource are essential: powerful programming tools, and knowledgeable staff to use them.

Although it is possible to develop a tiny expert system on a personal computer, it is generally wise to develop and run systems on powerful machines. IBM-AT and Apple Macintosh may do, but even larger ones are better.

Similarly, although expert systems have been developed using shells, it is hard to build and modify an expert system of any size or complexity unless more powerful tools are used. This necessitates a language like *PrsLog* or *LISP*, or a tool such as *OPS5*.

C15 Teams of programmers, domain experts and knowledge engineers have developed most major commercial expert systems. While expert systems aimed at education (rather than at training) are not likely to attract a similar level of resourcing, a team approach is still highly advisable. Even without that, small, special purpose systems can still be produced. However, to be reasonably productive, the individuals who develop such systems must be part of a group of people with similar interests and facilities, to allow easy discussion and advice.

C16 Educators clearly need training in how to identify promising applications, and in how to assess the resources needed. As yet, there has been little research into the suitability of particular shells for specific educational applications. It is, however, true to say that, in general, expert system shells take longer to learn and are more complex to use than manufacturers would have us believe.

For this reason, it is sensible for colleges and training establishments to set up groups to share information about the educational uses of expert systems. The groups could also participate in seminars to raise awareness of the technology's potential.

C17 In future, people may approach FEU for information about institutions with expertise in this field. Regional Development Centres (set up by the DES to promote the use of IT in non-advanced further education) may request the starter pack of expert system knowledge bases developed by an FEU/MSC project at Kingston College of Further Education.

All being well, these centres will play a valuable part in the dissemination and evaluation of knowledge bases.

APPENDIX D

INTERACTIVE VIDEO

Why interactive video?

D1 Teachers and trainers have long been aware of the effectiveness of audio-visual presentation. It supplements text with sound and/or pictures to enhance the learning experience. However, the learner remains essentially passive, simply receiving information through eye and ear.

Interactive video (IV) allows access to different sequences in a video disc or tape. This may be controlled by the learner, or a computer program selects sequences in response to input. The learning experience is therefore interactive.

A well-written computer-aided learning program may offer several different routes through the material, including remedial loops to aid understanding or assimilation. However, there still only one destination. In contrast, well-designed IV caters not only for different learners, but for different outcomes altogether.

Once a video disc exists, its contents are fixed – however, it may be packaged with different computer programs to allow access to different video sequences at different levels in different contexts.

D2 While computer graphics and text are effective, IV also offers more realistic 'pictures'; in some teaching and training situations this is a crucial factor. Thus interactive video offers the advantages of both video and computer technologies. In a single medium, it combines not only visual (graphic and video) and textual information, but also computer-aided learning techniques.

Interactive video can therefore support a wide range of teaching and training needs. It is particularly useful in teaching interpersonal skills and for simulating training situations that would be dangerous, time-consuming or costly in real life.

Applications

D3 Broadly speaking, the current uses of IV fall into four groups:

- ◊ training/education
- ◊ information storage
- ◊ point of sale
- ◊ games

Here our main concern is with the first of these.

D4 Interactive video has been used successfully in a number of training areas:

- ◊ electronic maintenance/repair manuals
- ◊ skills training/upgrading (of welding, for instance)
- ◊ interpersonal skills (like sales, management, decision making)
- ◊ life skills (including for the disabled)
- ◊ basic knowledge training.

D5 Britain has as yet few IV programs specifically designed for education. The Interactive Video In Schools project (funded by the DTI) started in January 1986; it is now testing eight packages produced for a variety of curriculum areas. Some of these will be of value in further education. For instance, there is a package to teach French, one on mathematical concepts, one for geography, and another on the problems that face young people today. All eight run on BBC micros and the RM Nimbus, while there is support for several video disc players.

One difference between these eight packages and a typical training suite is that practising teachers play an essential part in the design exercise. Indeed, the material is for use with teacher support rather than as a stand-alone resource.

D6 The educational uses of IV include simulations and case-studies. Such products are of particular use with science, engineering and medical students. The medium also suits language learning, and several institutions are working on ideas in this field.

D7 CET recently identified four relatively distinct modes of use of interactive video in education:

- ◊ as a class teaching tool by the teacher;
- ◊ as a small group learning medium (where groups of two to four learners use the disc as a tutor, responding to questions and discussing the material);
- ◊ for individualised learning;
- ◊ as a resource for data access by groups and individuals (where the disc carries a library of audio and video reference material).

Potential

D8 On one level, we can see interactive video as an enhancement of computer-aided learning; however, in the area of information storage its potential is much greater. This follows:

- ◊ the sheer volume of information a video disc can hold;
- ◊ the variety of forms in which it can present this (text, manuscript, computer graphics, slides, moving film);
- ◊ the fact that any of this information can be accessed almost instantaneously.

A single disc can hold 1,000 computer programs, 100,000 pages of text, 5,000 slides, twelve minutes of moving video, and eight hours of narrated film strip – and this is only one configuration.

Clearly the facilities offered by interactive video have great potential for self-directed learning and discovery at all levels of education.

D9 For further information, contact CET and/or the National Interactive Video Centre.

APPENDIX E

GLOSSARY OF ABBREVIATIONS AND ACRONYMS

AECAL	Audio-enhanced computer-aided learning
AI	artificial intelligence
AIT	advanced information technology
APT	adult preparation training
BLAISE	British Library Automated Information Service
BTEC	Business and Technician Education Council
CAL	computer-aided learning
CACGS	computer-aided career guidance service
CBT	computer-based training
CD-ROM	compact disc ROM
CET	Council for Educational Technology for the UK
CML	computer-managed learning
DELTA	Development of European Learning by Technological Advance
DES	Department of Education and Science
DTI	Department of Trade and Industry
ECCTIS	Educational Counselling and Credit Transfer Information Service
ESG	Education Support Grant
ESRC	Economic and Social Research Council
FE	further education
FEU	Further Education Unit
FHE	further and higher education
IT	information technology
JANET	Joint Academic Network
LEA	local education authority
MSC	Manpower Services Commission
NERIS	National Educational Resources Information Service
NIVC	National Interactive Video Centre
OU	Open University
P(A)BX	private (automatic) branch exchange
PCAS	Polytechnic Counselling and Advisory Service
PICKUP	Professional, Industrial and Commercial Updating
TAP	Training Access Point
TTNS	The Times Network System
UCCA	Universities' Central Clearing Association

APPENDIX F

FURTHER READING

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USEFUL JOURNALS IN THE AREA INCLUDE:

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BJET (*British Journal of Educational Technology*) – published by the Council for Education Technology.
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Desktop publishing

GENERAL INTRODUCTION

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